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SEPTEMBER 1999

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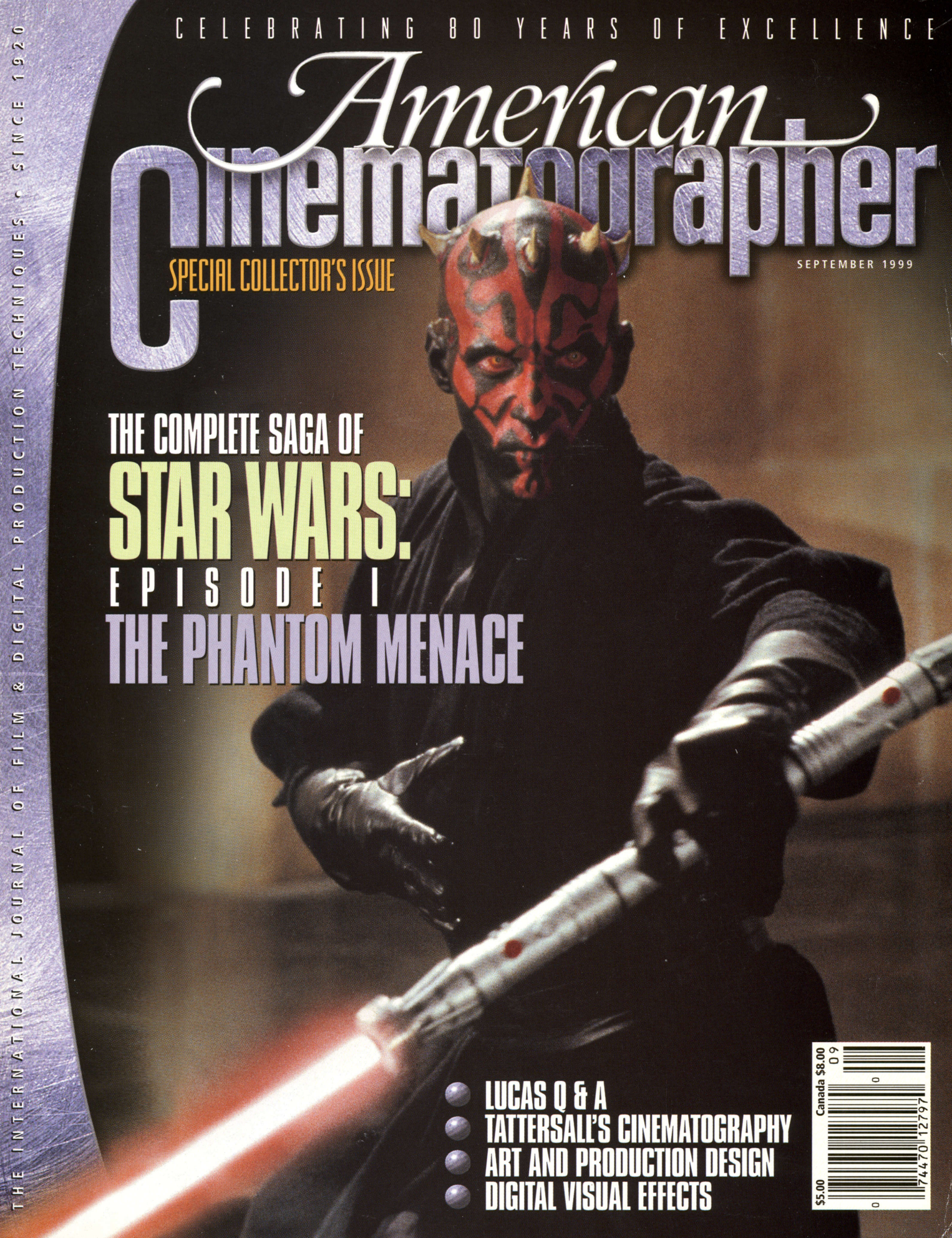

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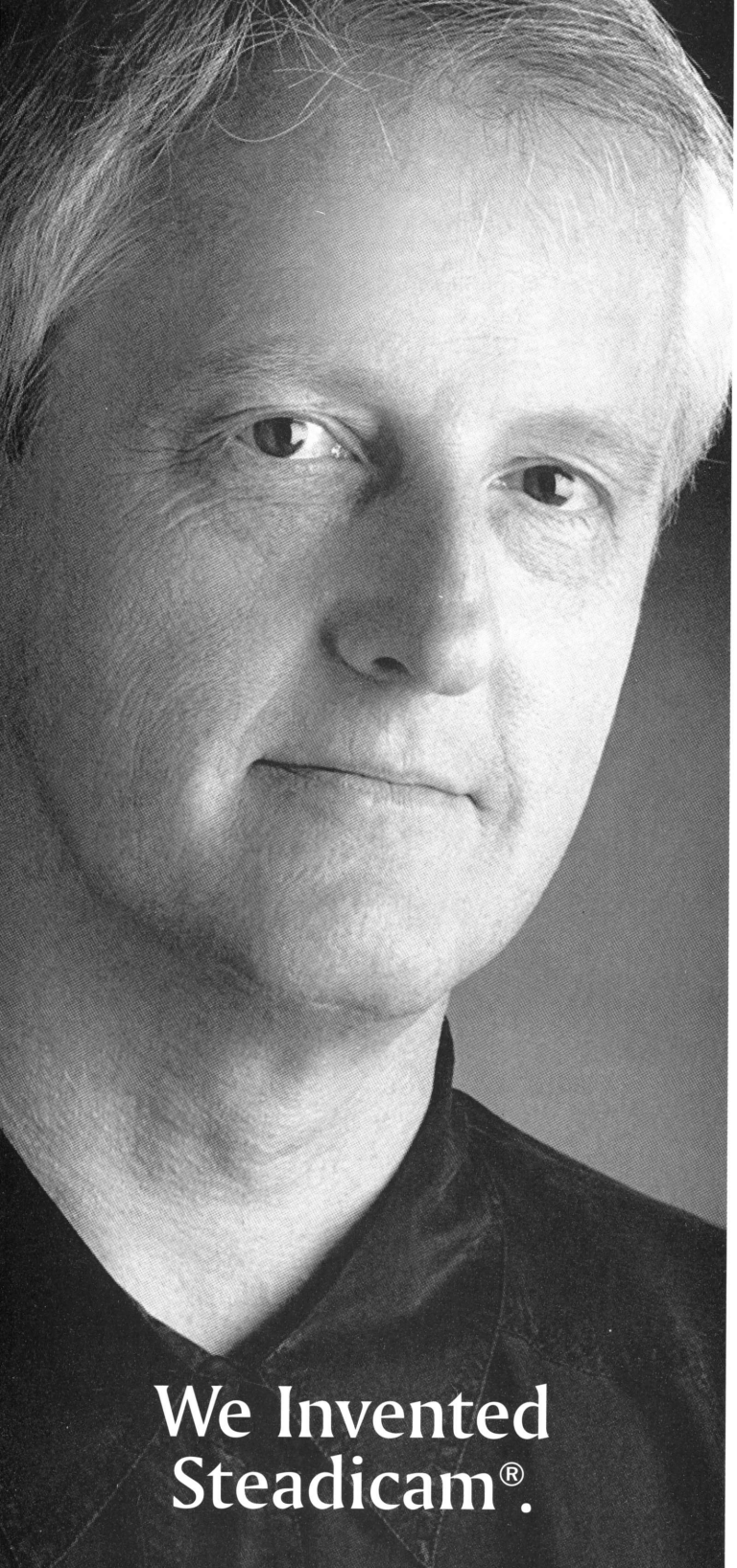

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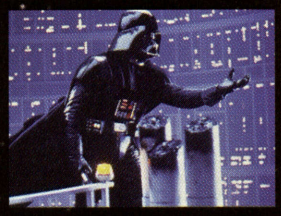
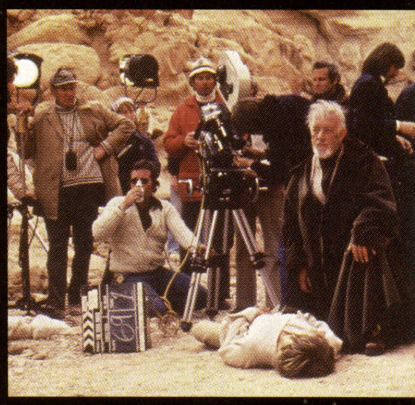
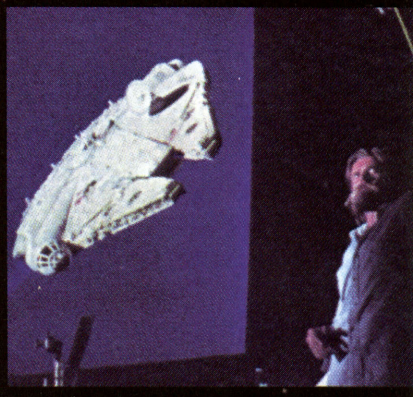


STAR WARS: John Dykstra, ASC's detailed report on the miniature and mechanical effects, revealing the step-by-step approach used to create thrilling space battles. Also, a complete account of the film's composite and optical photographic effects, by Robert Blalack

THE EMPIRE STRIKES BACK: Richard Edlund, ASC writes about setting up Industrial Light & Magic and the special visual effects. Dennis Muren, ASC is questioned about the film's effects photography, and Peter Suschitzky, BSC discusses his lighting and camerawork.

RETURN OF THE JEDI: Cameraman Alan Hume, BSC writes about his work at Shepperton Studios, while James Glennon, ASC vividly describes the location work done in the United States. Also covered are matte painting effects, effects art direction, and Phil Tippett's creature designs.





The archives of American Cinematographer have been opened to reveal the photographic and visual effects methods used to create Star Wars, The Empire Strikes Back and Return of the Jedi. A total of 27 individual stories and hundreds of rare images detail how these classic films were made. Also featured is coverage of the techniques used to restore and update these films for their respective 1997 Special Edition releases.

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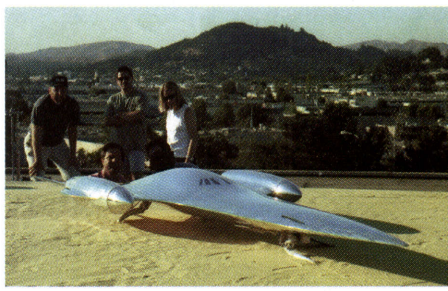

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On Our Cover: The evil Darth Maul (Ray Park) prepares to battle two Jedi knights to the death in *Star Wars: Episode I — The Phantom Menace,* directed by George Lucas and photographed by David Tattersall, BSC (photo by Keith Hamshere, courtesy of Lucasfilm Ltd.).

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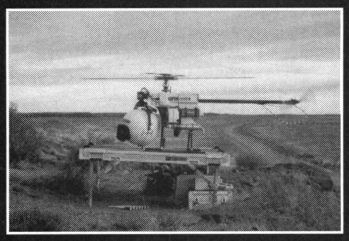

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September 1999 Vol. 80, No. 9
The International Journal of Film & Digital Production Techniques • Since 1920

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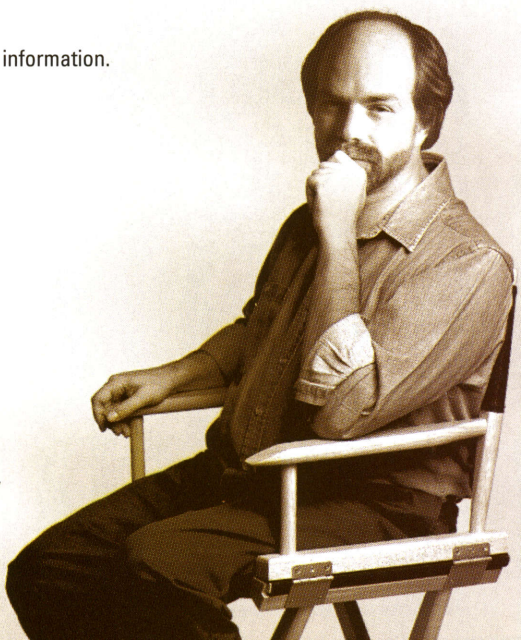

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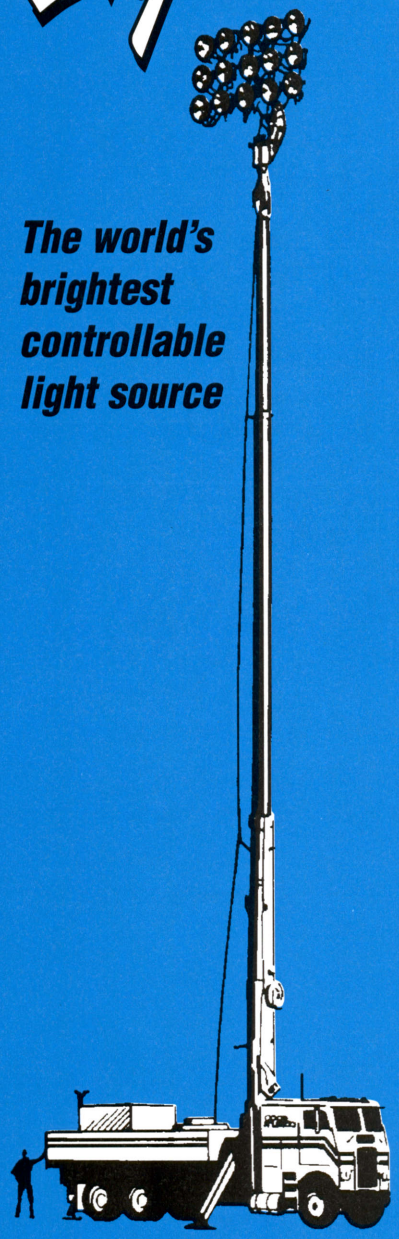
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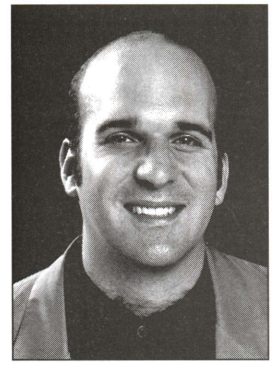

During the summer of 1977, *Star Wars* took the moviegoing world by storm — and by surprise. Arriving on big screens seemingly out of nowhere (a virtual impossibility in today's hype-laden media culture), George Lucas's science-fiction fantasy struck a deep chord with audiences of all ages and nationalities, who lined up for hours to experience the film's visceral thrills again and again. By placing the unironic heroism of classic Saturday-afternoon serials in a mythological framework inspired by the works of author Joseph Campbell, Lucas created an epic tale with truly universal appeal.

Since that epochal moment in motion picture history, *Star Wars* has grown into a global obsession of monolithic proportions. Canonized by a rabid, quasi-religious fan base, Lucas is now viewed as the high priest of this fictional kingdom, and his straightforward saga of good and evil has become a generational touchstone for millions. In short, the word "phenomenon" was invented to describe what Lucas has wrought. (Longtime *AC* readers certainly covet the hard-to-find issues containing our coverage of the original *Star Wars* trilogy — June 1977, June '80 and June '83. The articles can currently be accessed on the ASC website at www.cinematographer.com.)

When *Star Wars* was first re-released, audiences puzzled over its new subtitle, which read *Episode IV: A New Hope*. Lucas explained that he had decided to begin in the *middle* of a tale that would eventually include nine installments. He later scaled his ambition down to a six-part saga, but 16 years would pass between the release of *Episode VI* (a.k.a. *Return of the Jedi)* and the first of three prequels, whose title hewed to the playful spirit of serials: *The Phantom Menace*.

The mere announcement of the project caused a Richter-scale rumble of excitement and expectation that perhaps no filmmaker could hope to surmount. Undaunted, Lucas outlined his desire to use cutting-edge computer technology to make a radical departure from traditional filmmaking methods. Dubbing his experiment "the digital backlot," the director maintained that he would seek to achieve maximum control over the film's imagery via crafty editing and an unprecedented use of computer-generated imagery.

As this issue demonstrates, Lucas achieved his goal: *The Phantom Menace* heralds the birth of a new filmmaking paradigm with important implications for everyone who works in the motion picture industry. Meanwhile, Lucas plans to continue his experiments on the next installment of *Star Wars,* vowing to shoot with digital video. Stay tuned for further updates from the futuristic frontier.

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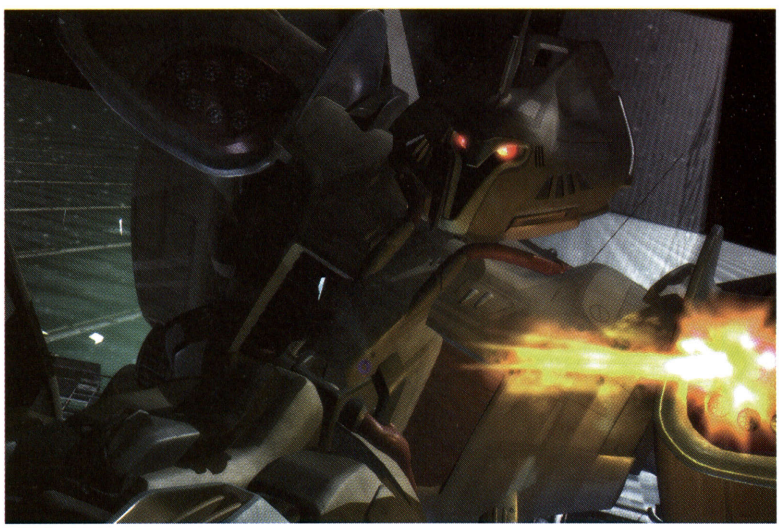
Production Slate

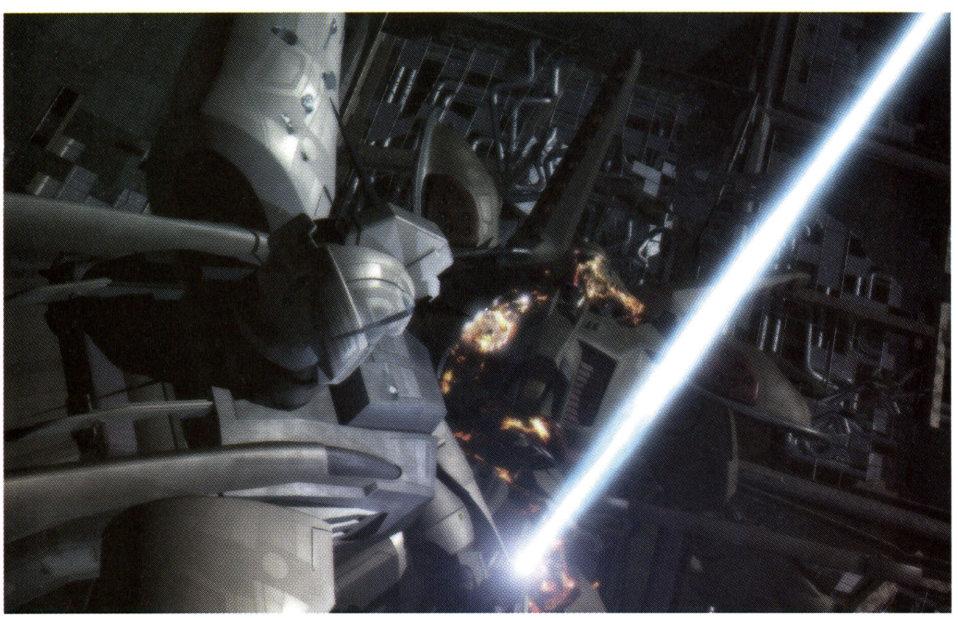
compiled by David E. Williams

Bringing *Anime* to Life

by Lance Sherwood

If *Star Trek* is America's favorite sci-fi television series, then *Gundam* could be described as Japan's number-one choice for sci-fi *anime* — animation designed for mature audiences. The most successful Japanese *anime* series, *Gundam* turns 20 this year, and its producers, the Bandai Group (one of the world's largest toy manufacturers), and Sunrise Entertainment (one of Bandai's animation production arms), will celebrate the occasion with the first live-action *Gundam* production, a two-hour television movie set to air in Japan and the rest of the world later this year.





Giant warriors in mobile suits face off in *G-Saviour*, an animated telefilm featuring CG effects work by Santa Monica-based Digital Muse.

The movie, entitled *G-Saviour*, has been completed in association with a Beverly Hills-based production company, The Polestar Group, who chose visual effects house Digital Muse of Santa Monica to play an integral role in the creation of the *Gundam* world. It was no coincidence that the producers selected Digital Muse — the company has created effects for both *Star Trek: Deep Space Nine* and *Star Trek: Voyager* over the past several years.

First introduced in 1979, *Gundam* tells the story of a future history in which towering robot-like machines piloted by a new breed of man battle against evil forces that conspire to disrupt the peace. A unique departure from typical animated series, *Gundam* presents a universe filled with giant space-based cities, as well as stories filled with political intrigue.

The two defining elements of the series are 6-story-tall machines called "mobile suits," and the massive space settlements in which the Earth's greatest cities are reborn. "As kids, we loved to imagine what space would be like in a couple hundred years," says John F.K. Parenteau, a managing partner of Digital Muse and the visual effects co-supervisor for the *G-Saviour* project. "This film brings all of those fantastic ideas to life. What kid wouldn't love the concept of flying around in 60'-tall, man-shaped machines?" The series has proved to be long-lasting, capturing the

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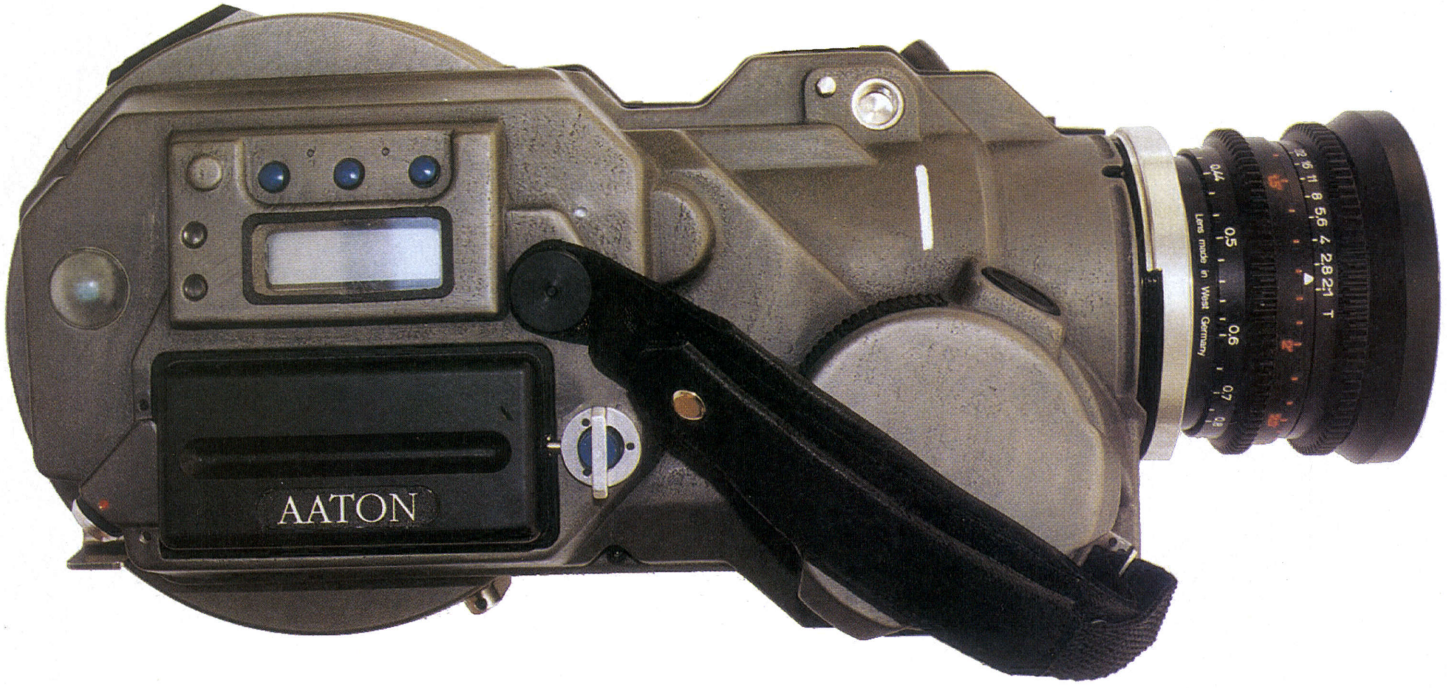

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A squadron of warriors in attack formation. Digital Muse utilized motion capture to form the basis of their animations.

hearts and imaginations of several generations.

Polestar and Sunrise enlisted the help of Digital Muse early in the production of *G-Saviour*. Their task was "to create a believable look," says Parenteau. "We couldn't simply match the *anime*, since we were hoping for photorealism. But we knew it would be a difficult sell. Essentially, we're talking about 60'-tall mobile suits here!"

In order to accurately render the scale and presence of these mammoth fantasy devices, "we did a lot of research into large machines," recounts visual effects co-supervisor Bruce Branit. "We took field trips to freight docks and stood next to these massive cranes, which were very impressive."

With both a visual reference and a mind to the original series, Digital Muse artists focused on finding a careful balance between realism and art. A story was carefully sculpted to take advantage of Muse's talents. Featuring over 100 effects shots, most of which involve 3-D character animation, *G-Saviour* could prove to be a defining moment not only for the *Gundam* franchise, but for Digital Muse as well. "Our artists love it when a completely original concept comes in," Parenteau enthuses. "We feel that we've always been challenged by our work on *Star Trek*, as well as our various commercial and film projects. *G-Saviour* is no different."

A nine-person team commenced work on the effects a month before *G-Saviour*'s principal production. "We had a unique opportunity to not only be involved in production, but also to help guide shot selection with the producers and director," said Parenteau, who spent nearly two months in Vancouver for preproduction and the shoot. While production commenced, the team began work on the show. Extensive computer modeling was required to create the multiple environments described in the script. "Most shows take place in a single arena, either in space, on land or even underwater," says Branit. "*G-Saviour* had significant sequences in each of these environments." The staff was required to research everything from massively scaled objects to underwater phenomenon such as "black smokers" — a type of volcanic vent on the ocean floor that discharges superheated water and ash materials. With these concepts in mind, the crew set out to bring a realistic edge to each effect.

One key initial scene in the *G-Saviour* storyline was a battle-suit brawl. Rather than choosing motion capture to form the basis of the required animation, Branit chose a simpler technique of roto-capture. "We were worried that motion capture would not only be too fluid, but would also limit our flexibility," he explains. "We chose a method that allowed us to create realistic motion, and

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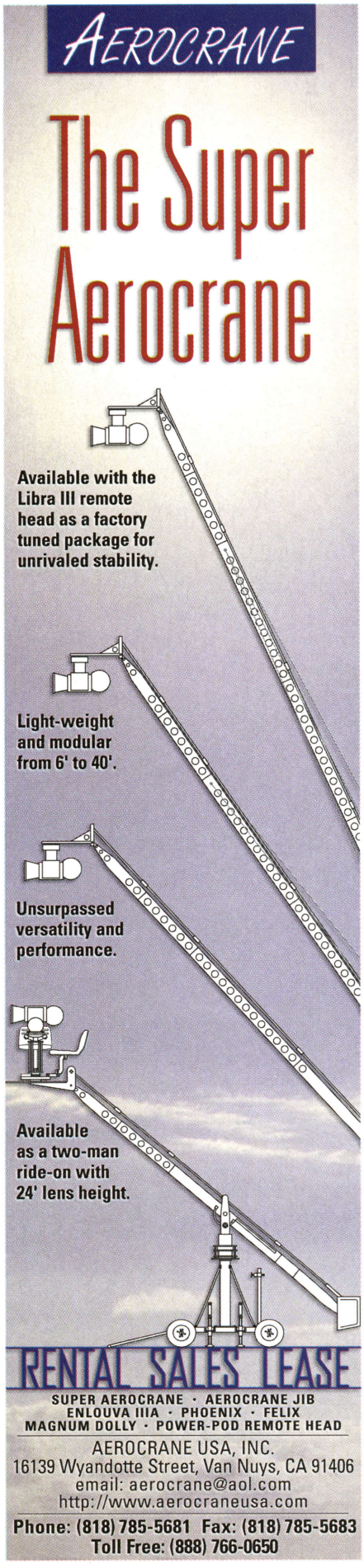

yet make changes and finesses."

Utilizing actors traditionally trained in swordplay, the crew videotaped carefully choreographed action. The 3-D motion data was then used as a template for animation. "You really get a sense that these giant suits are fighting," said Parenteau. "We weren't forced into sticking with motion that made the suits look too small. This technique allowed us to scale and modify the action to imply more weight and momentum."

Utilizing Lightwave 3D as their primary software, Branit and Parenteau rendered each shot in numerous element passes, then finished each shot with Eyon's Digital Fusion or the in-house Quantel Henry V-Infinity. The flexibility of both systems allowed for a series of finesses that would have been impossible with slower compositing packages. "Our finishing time was measured in hours rather than days," says Rony Soussan, composite artist on the *G-Saviour* project. "I was able to quickly show Bruce and John choices for looks, and then send them off to render. Minutes later, we could look at the final shot." With compositing duties split between Soussan and composite supervisor Mark Breakspear, the project was completed in record time.

Re-creating a Tragic History

by Holly Willis

"I alone lived to tell the tale," intones Captain Ahab in *Moby Dick*, author Herman Melville's classic tale of self-destructive vengeance. A similar sense of survival drove director Joseph Lovett to make *The Accident*, a documentary account of his family that borrows from the wealth of images taken by Lovett's father, an amateur filmmaker/photographer. "One day as a child, while I was taking a bath, it dawned on me that I was the youngest of the family, so much so that they were all going to die, and I'd be left behind," says Lovett, a former producer for ABC-TV news magazine *20/20* who gained some of his first postproduction experience as an assistant editor on the seminal PBS documentary series *An American Family*. "Ever since that time, I've wanted to tell the story of my family, mainly because it was a 'dramatic' family."

Although everyday drama was plentiful enough to capture Lovett's interest, many of his family members did indeed die early deaths, making the chronicle of family history that much more important. His mother's accidental death is what truly inspired this film; the 13-year-old Lovett was with his mother on the day she was killed in a bizarre auto accident outside their home, and became the only witness to the horrible mishap. The tragic events' images and sensations haunted Lovett for years. Not until he re-created the mishap decades later, in the final stages of production on *The Accident*, did Lovett make peace with his trauma.

Lovett's father, a volatile and jealous character, was also a dedicated photographer and filmmaker. He made stereoscopic pictures, bought one of the first 3-D cameras, and had a strong devotion to 16mm cinematography. Lovett constructed a large part of his documentary by drawing on his father's multitude of photographs and extensive film archive. In addition to the prints and 16mm footage, Lovett also incorporated Sony reel-to-reel black-and-white video footage shot in 1974, and images captured on ¾" Beta. The disparate parts were assembled on an Avid, translated to DigiBeta, and then output to film at Du Art Film & Video in New York. According to Lovett, Du Art allowed him to perform extensive tests, and gave him the best transfer possible within his budgetary constraints.

The most recent footage, which features Lovett going through the attic of his childhood home, as well as the restaging of the auto accident, was shot by cinematographer Bill Charette of LeCain/Charette Associates. A frequent collaborator with Lovett, Charette got his start at Boston-based PBS station WGBH. "They led the country in developing new technologies and trying out new equipment," he explains. "When the first portable video cameras

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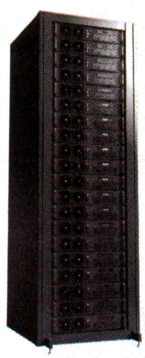

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Scenes from *The Accident*, which utilizes re-creations and archival footage to tell a family's tale of tragedy.

came along, we were among the first in the U.S. to get them, and I was always trying to get my hands on that new equipment."

Having used video in its early stages, Charette has watched the technology develop significantly in the last two decades. "The biggest change has been in the sensitivity you get with the cameras these days," he says. "In the studios of yesteryear, you'd generally light a picture at 350 footcandles. Now, we can make pictures with 10 footcandles. When I'm lighting a shot, I generally try to work at 50 to 75 footcandles and an aperture of f2.8 — that's the combination I use the most when I have total control."

On *The Accident*, Charette wielded a Sony BVW-600. He and his partner, Larry Lecain, began shooting with Sony cameras nine years ago, using the BVW-400. "Sony was really ahead of the game with their one-piece camera and onboard recorder," he says. "Today's high-end broadcast cameras are incredibly sensitive. In one shot, Joe was going through some letters in an attic, and there was a little bit of light coming in from a window that was quite a ways off near a stairway. I pulled out one of those Flexfill reflectors, and as I was sitting on the floor, I leaned the reflector under the camera and bounced a little additional light onto his face while he was reading. It's one of the nicer moments in the film, but several years ago, I never would have been able to do that with a video camera — it would have been a muddy, ugly, technically unacceptable shot.

"Another nice feature about these cameras — at least with the Sony 600s on up — is that you have a menu to control various functions," Charette adds. "Through the menu, we have access to the gain controls. Normally, I set the camera at plus six and plus nine. It's so easy to go to that menu and choose anything from -3 to +30db. I don't know that I'd ever go over +9dB, but at +6 you get an extra stop, which might allow you to shoot in a low-light situation that might otherwise not be possible. Typically, you used to have a choice of +9 or +18, and so forth."

Since he tends to shoot a lot of his documentary projects handheld, Charette likes to use a wide-angle lens. "I used a Nikon S9 x 5.5, and that's another advantage, because the lenses have gotten so much better. It's a tremendous advance to have a 5.5mm

Photos courtesy of Lovett Prods.

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On the day that the crew re-created the freak auto accident, Charette carted in a sled dolly and a crane to complement the other setups he'd mapped out. "Before the day we shot the accident scene, Joe and I surveyed the location: Joe's boyhood home, which was the actual scene of the accident. He described that day very vividly to me. Before the shoot rolled around, I made a list of about 20 shots that I wanted to get. I wanted to give Joe a variety of angles and movement, so I incorporated POV, handheld shots running behind the boy who played Joe, as well as shots done with a 16' crane and a sled dolly on 40' of track. We were fortunate to have side-by-side driveways at our disposal, which allowed us to easily do a hubcap-high tracking shot as the car rolled out of the driveway."

For both Lovett and crew, that day's shoot was understandably intense from an emotional stand-point. "I had carried these images in my mind all of my life," says Lovett. "The accident was something that was always there. Ever since we shot the accident on tape, though, it doesn't play in my head anymore. I've replaced the real images with ones that I've created, and there's a greater sense of control. When something like that happens to children, there's only so much they can do with it — they don't have the support, the power or the strength [to deal with its implications]. But as an adult, you can go back and try to heal that wound."

Revisiting a Fictional Past

by David E. Williams

The indie film scene may seem to be a modern-day phenomenon, but more than four decades ago, English filmmakers Kevin Brownlow and Andrew Mollo were diligently at work on their frighteningly inventive indie feature *It Happened Here*, which was covered in *AC*'s July 1957 and March '66 issues.

Filmmaker Kevin Brownlow wields his Bell & Howell while filming battle sequences for *It Happened Here*.

The double-issue coverage was necessary because the picture took eight long years to complete, and was only released in the U.S. some time later in a severely edited form. (The complete story can be found in Brownlow's insightful 1968 making-of book, *How It Happened Here*.)

Photographed in a documentary-like style, *It Happened Here* was the first film to depict the chilling premise of what might have occurred had Nazi Germany successfully invaded England in 1940 and established National Socialism as the law of the land. The story is seen through the eyes of Pauline (Pauline Murray), a nurse who finds that she can only help save the lives of her countrymen by joining the Immediate Action Organization, a paramilitary group that teaches hand-to-hand combat

Photos courtesy of Milestone Film.

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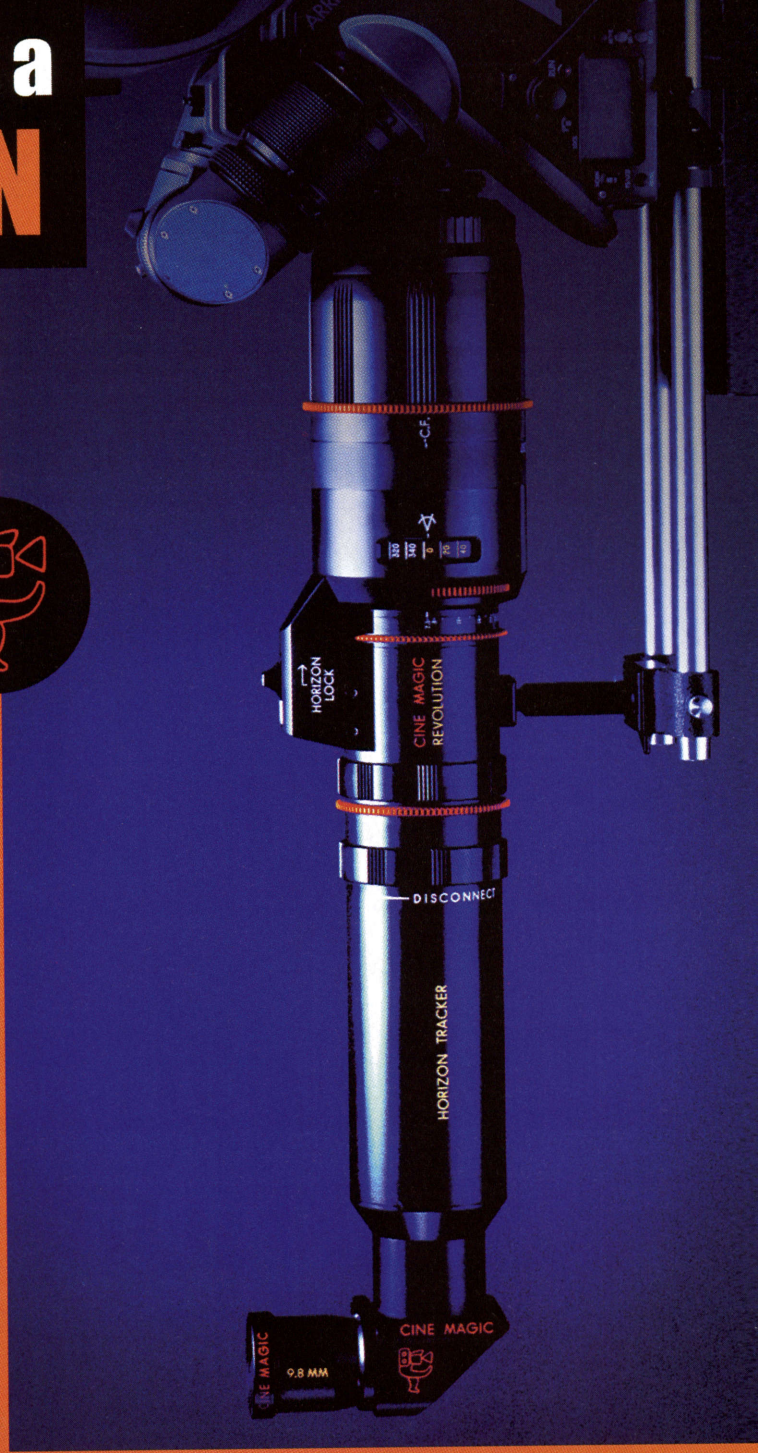

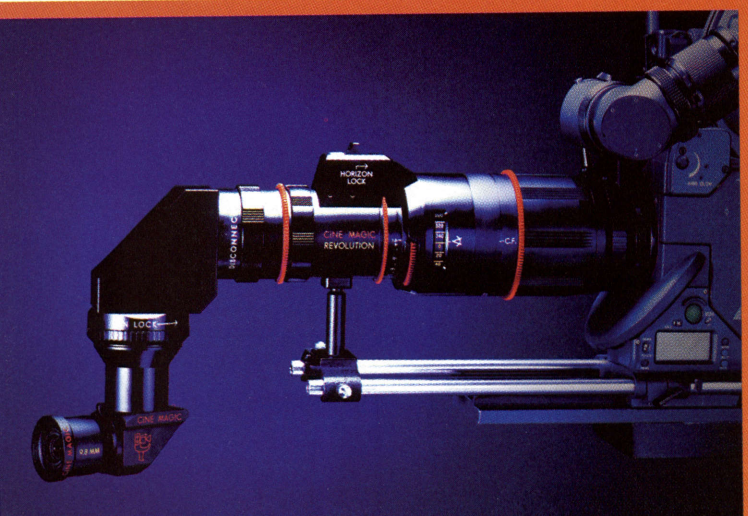

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German soldiers parade through London during a "rally" sequence staged in Trafalgar Square.

and marksmanship along with first-aid skills. Despite Pauline's good intentions, she is marked as a Nazi collaborator.

The then-teenaged Brownlow and Mollo, who jointly wrote, produced and directed the picture, were sticklers for absolute authenticity, and spent much of their lengthy production schedule collecting vintage German uniforms, weapons, vehicles, and accompanying props in the effort to bring realism to their fantastic story. This process was also dictated by their decision against using stock WWII footage to bolster their production values.

The amateur production began in May of 1956, with Brownlow serving as the director or photography and shooting in 16mm with a Bell & Howell 70 DR camera on Eastman Plus X neg stock. After some trial and error, several scenes were completed by 1962 — including a "Nazi rally" sequence filmed in London's central Trafalgar Square, featuring dozens of extras dressed as S.S. stormtroopers and Hitler Youth. The footage impressed director Tony Richardson (then preparing *Tom Jones*), who had employed Mollo as an assistant director on *The Loneliness of the Long*

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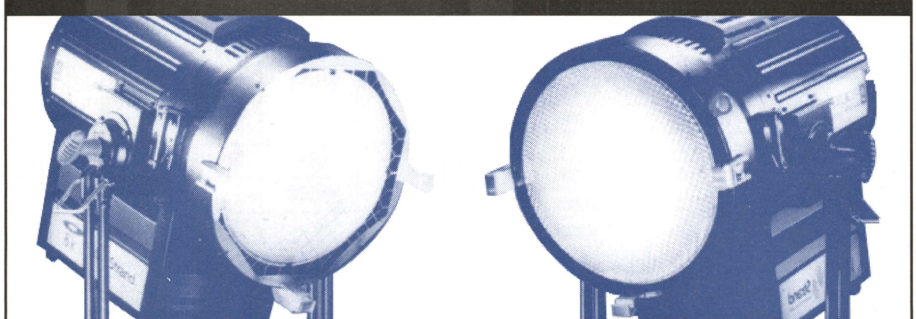

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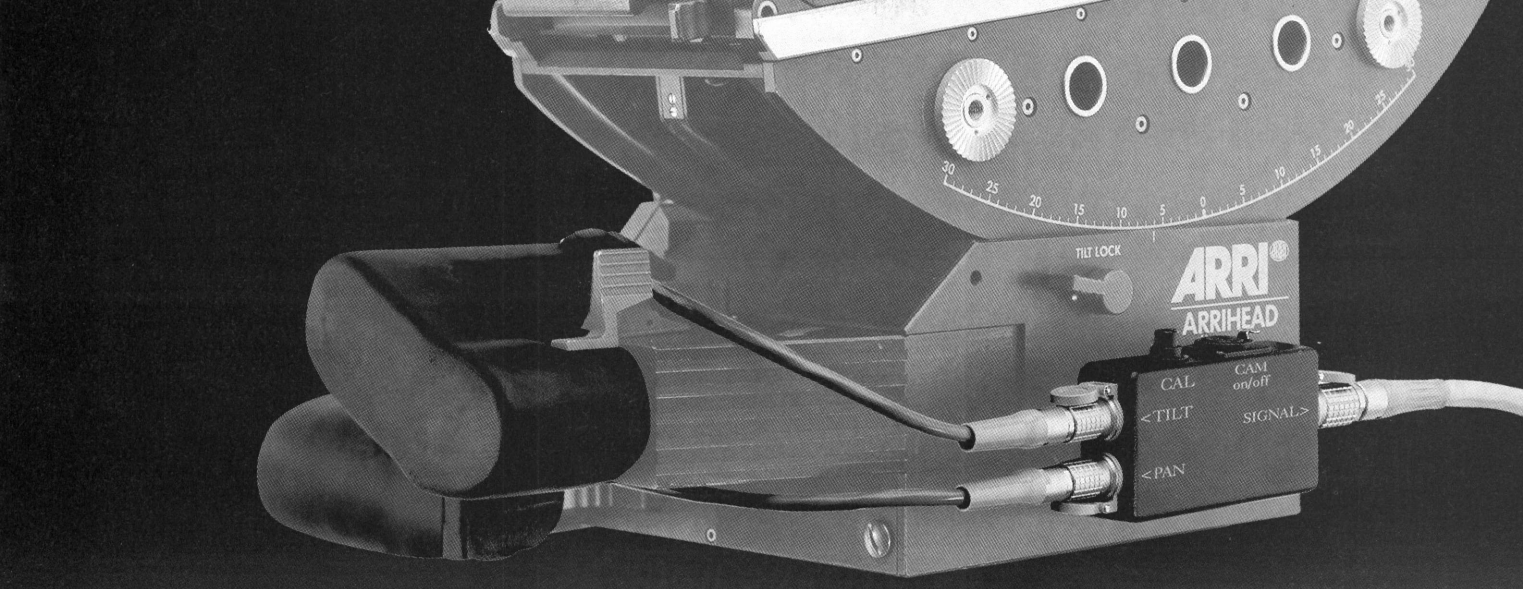

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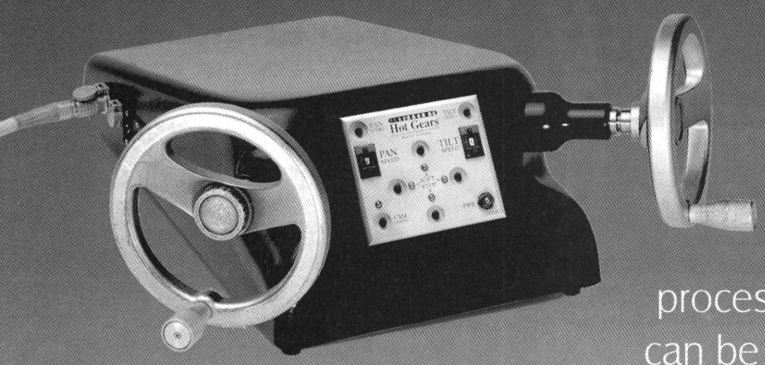

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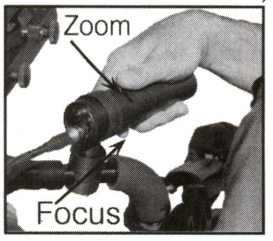

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Pauline (Pauline Murray) is compelled to join a Nazi paramilitary unit in order to save her countrymen.

Distance Runner. Richardson offered Brownlow and Mollo the completion funds they desperately needed, inspiring them to rewrite the picture and shoot the remainder in 35mm.

The duo subsequently enlarged their crew and enlisted the aid of 22-year-old director of photography Peter Suschitzky (who would later gain prominence as a cinematographer on such films as *Valentino, The Empire Strikes Back,* and *Naked Lunch*). Reinvigorated, the filmmakers drew up a new 40-day production schedule. Using an Arriflex 35 IIB, Suschitzky primarily shot with Ilford FP3 and HP3 stocks. (Some Eastman Plus-X and Double-XX short ends were also donated to the show by Stanley Kubrick, who had just wrapped *Dr. Strangelove* and was also intrigued by Brownlow and Mollo's creative spirit). All of the 16mm footage was later scrapped, save for the Trafalgar Square sequence, which was blown up to 35mm and included in the final cut.

Brownlow (now a noted film archivist and historian, whose books include the new *Mary Pickford Rediscovered*), recently worked with New York-based Milestone Film to have the director's cut of *It Happened Here* released on home video in the U.S. While the film suffers slightly from the rigors exacted by its extended production schedule and minimal budget (a total of $21,000), it remains an emotionally poignant depiction of a history that fortunately never came to pass, as well as a testament to the dedication and tenacity of two young filmmakers.

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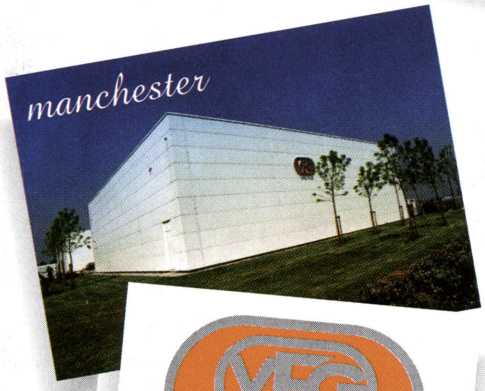

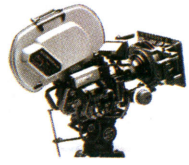

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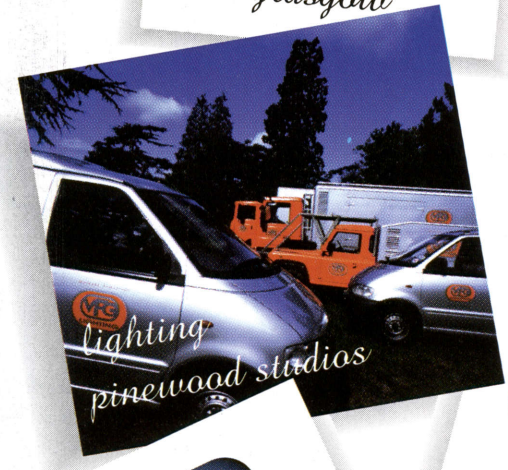

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THE IMAGE OF CHOICE

Master of His Universe

George Lucas discusses *The Phantom Menace* and the impact of digital filmmaking on the industry's future.

Interview by Ron Magid

Unit photography by Keith Hamshere

As George Lucas prepares to transform San Francisco's decommissioned Presidio military facility into his base of operations, he's also undergoing his own transformation of sorts. With virtually all revenues from the licensing and exhibition of his most recent blockbuster, *Star Wars: Episode I — The Phantom Menace,* flowing directly back into Lucasfilm's coffers, Lucas won't have to worry about reinvesting everything he makes back into his own companies anymore, something he's done for the past 20 years. As one associate put it, "George is going to have something he's never had before: liquid assets."

At 51, Lucas will now be able to marshal those assets to do the kinds of things he maintains that filmmakers have always wanted to do, but which no filmmaker in history has been able to afford or even imagine. Not only will Lucas continue to create images we've never seen before, he intends to remake "cinema" itself.

The Phantom Menace, with its CG characters, spaceships and settings, proved the viability of the "digital backlot," but it's the things you don't see in the epic film — the many shots that were cobbled together from various takes or other shots, or the replacement of actors' mouths to accommodate new lines of dialogue, all in lieu of reshoots — that get Lucas most excited about cinema in the digital realm.

While promoting *Episode I* in Europe, Lucas spoke with *AC* about his views on the future of cinema, the role of the cinematographer and the nature of production in the computer age, and the advent of digital exhibition.

American Cinematographer: **Did the digital-backlot strategy work as advertised?**

George Lucas: Yes. We haven't done a final cost analysis on the film, but it seems to have been a big cost-saver. Obviously, we couldn't build a

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lot of the sets and things [practically]. Even if we'd tried to do miniatures and put them back behind the action, we had a lot of camera moves and it would have been very difficult to match all of that up doing traditional photography.

Which aspects of the plan didn't work as you had hoped?

Lucas: It worked better than I expected. We were experimenting, trying to learn how the process works, and the only way we can really understand that is to get a final accounting on the film. We've taken the cost of building the sets [practically], and the cost of building them digitally, and now we're sort of back-engineering to see what it would have cost if we'd had to create them in a traditional way and put them into the finished film, which is also cheating. We're going to do that shot by shot and assess which things actually worked and which things didn't work. The whole point for us is not to do everything digitally or to use the digital backlot, but to do things as inexpensively as possible.

But is it really more cost-effective to create entirely new shots by recombining elements from scenes you've already shot, or by digitally replacing an actor's mouth to accommodate new dialogue, as opposed to reshooting?

Lucas: Reshooting is very expensive, and we're obviously bringing the cost down. The biggest cost in almost any of those [digitally reconfigured] shots was the price of converting the film to digital. We knew that if we started out digitally, it wouldn't cost very much at all. A lot of the stuff we redid — like shooting a new set of lips to glue onto an actor, putting an extra here or there, or things like that — was shot digitally, which was certainly more cost-effective.

Did filming scenes on partial sets — or, in some cases, just against bluescreen — challenge you to find less abstract frames of reference for the actors?

Lucas: It really depends on what they're doing. We weren't *just* doing special effects scenes; a lot of the scenes were simple dialogue exchanges between two or three people, or shots of somebody walking away and turning around. When we shot ordinary scenes of two actors standing in the middle of a jungle, we didn't have to stage or do anything differently than if we had actually been in the jungle, [as opposed] to being in a parking lot.

What is necessary is what you might describe as a more old-fashioned style of movie acting, which is more like theater. The whole idea of method acting and being in the character — and having all of this *real* stuff around you in order to be able to do your part — is necessary for some actors today who are used to the sort of 'realism' of the street films that have been done [since] the mid-Sixties. Especially in Britain, actors are trained more in the theater, and they are therefore [accustomed to] pretending the audience isn't there, or that some big, white shape is actually a building, or that a blue light is water. That type of acting isn't much different than more traditional film acting from the Thirties and Forties.

"[Digital post] gives the director, the cinematographer and the art director a lot more freedom to design the look of a movie, and to rethink the movie during the process of making it."

What about a child actor like Jake Lloyd, who obviously hasn't had that depth of training?

Lucas: He's very talented, and we barely ever got into a situation where he couldn't understand what was going on and 'pretend.' I mean, kids are very good at pretending. Also, most people misunderstand digital characters, in that they assume that there's no character on the set. There's always an actor there doing the lines; he's actually playing it, and the other actors can interact just like they could in any other kind of scene. Then, we end up hiring a second actor — the animator — to help interpret the performance. In that sense, we actually end up hiring two actors to create one character. But in terms of being on the set, and having the actors interact with each other, it's *exactly* the same.

You've taken some heat for the characterizations of Jar Jar Binks, the Neimoidians and Watto, because of what some critics have called racial stereotyping. But isn't it inevitable, when you're creating digital characters from scratch, that you have to draw on different human cultural types? Or is it possible to create 'alien' characters with no human reference points at all?

Lucas: Well, this whole issue of racial stereotyping in *Episode I* is completely absurd. That was started by the *Los Angeles Times*, and they had their own agenda that didn't have anything to do with the movie. I don't think anybody in their right mind — especially not people like the NAACP or the Jewish Anti-Defamation League — takes those kinds of things seriously. It seems that only the press wants to make something out of it, and they're obviously doing it to sell magazines or newspapers. I don't think they really understand what the definition of a 'stereotype' is! They can't; otherwise, they wouldn't be using [the term] that way.

The [truth] is that they *aren't* stereotypes. The only reason the press tried to make Jar Jar into a stereotype is because they thought

Continued on page 30

Opposite: George Lucas and actor Jake Lloyd confer while shooting a scene set on Tatooine.

SHOOTING DIGITAL?

Sony and Panavision strive to deliver a revolutionary new production camera.

by Jay Holben

Jedi master Qui-Gon Jinn (Liam Neeson) discusses the power of the Force with young Anakin Skywalker (Jake Lloyd) in a scene partially shot on HD video.

Director George Lucas has frequently said that he is planning to shoot the as-yet-untitled *Episode II* of his six-part *Star Wars* series on high-definition digital video, as opposed to celluloid. This feat would allow the filmmaker to bypass the time-consuming and expensive task of processing and digitizing film footage destined for digital effects work — and keep the picture digital from one end of production process to the other. (Digital theatrical exhibition is the final portion of this plan, as detailed in the sidebar on page 70.)

Toward this end, Sony's first prototype 24 fps, progressive-scan (1920 x 1080), high-definition cameras are slated to be to be delivered to Panavision's HD team this October. Panavision, currently hard at work designing newly calculated lenses for these camcorders, will add their own touches to the electronic and physical design of the unit before passing the final product on to Lucasfilm for extensive testing. "There will be some months of testing through the winter and into the spring," reports Larry Thorpe, vice president of digital acquisition and head of Sony's development team for the *Star Wars* project. "Based on all of the final tweaks we make, we will bring the mature cameras back to Panavision for the final decking-out, if you will, and then Panavision will lease them to Lucasfilm for the shooting of the next movie, which is planned to begin production in May or June of 2000."

Many early discussions were held regarding the best method of achieving Lucas's desired 2.35:1 aspect ratio. Early solutions involved employing anamorphic optics, but the additional 24 percent of image information did not overcome the considerable loss of optical quality inherent to the anamorphic elements. The revised concept is to photograph the next *Star Wars* installment spherically in a 1.78:1 (16:9) aspect ratio while composing for 2.35:1, and then digitally resample the image, cropping enough vertical information to achieve a 2.35:1 ratio with a final resolution of 1920 x 800. "That works without reduction in image quality because of the progressive scan technology," attests Thorpe.

The optics required for this new camera's success are promised to be nothing short of revolutionary. "We're developing some very high-performance lenses and other accessories," reveals John Galt, head of Panavision's portion of the project. "Our engineers will also be making some changes to the technology to specifically accommodate the requirements of filmmaking, as opposed to video production. Mainly we'll be working to embed ancillary data other than picture and sound, what we call 'Meta Data,' into the image — information such as lens focal length, iris setting, time code and so forth.

"As far as the lenses are concerned," he maintains, "the Primo Digital series will be among the highest-performance lenses ever made for a camera." To put this declaration into perspective, Galt adds that "35mm film has a diagonal of about 28mm [1.33:1]. The ⅔" HD format has a CCD diagonal of about 11mm [1.78:1]. Since we're projecting that 11mm on 50' screens across the country, the overall resolving power of the optics has to be twice that of 35mm lenses to get the same image quality." The relatively small CCD size is intended to make the overall camcorder unit more compact and production-friendly.

Galt says that the difference between 35mm and HD, in technical terms, is a magnification factor of 2.2 (when comparing 1.78:1 in 35mm to 1.78:1 in HD). For example, a 40mm lens in 35mm would be the equivalent of an 18mm lens in HD. This same magnification factor applies to depth of field as well, which is 2.2 times greater than that of 35mm film. This would require the Primo Digital lenses to be faster than conventional spherical lenses to match their depth of field. However, due to the dispersion limitations of the light-gathering prism in the HD camera (which is necessary to separate the incoming image into its primary colors for each of the three CCDs), the camera is not able to accept light below a certain level. Therefore, the fastest Primo Digital lenses will be in the range of T1.4 (the equivalent of about a T3 in standard 35mm). ■

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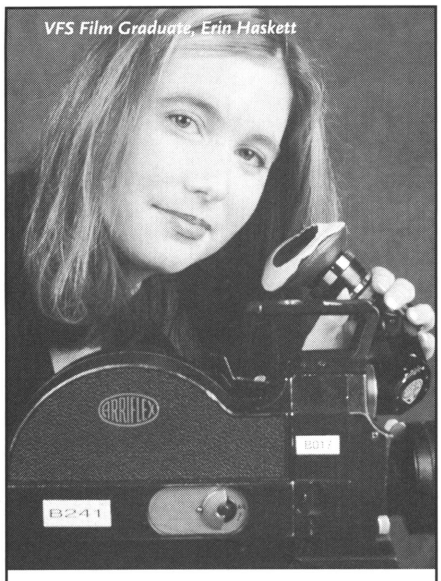

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Master of His Universe

he spoke with a Jamaican accent! But that idea was obviously [set forth] by somebody who's never talked to a Jamaican! I mean, if you showed the film to Jamaicans, they wouldn't understand [Jar Jar's speech patterns] any more than somebody who spoke the Queen's English! It's *not* a Jamaican accent; [the dialect] is completely made up. It doesn't even *sound* like a Jamaican accent. But you know the old racism bit, 'They all look alike?' Well, now, it's becoming 'They all sound alike.' The real racists, actually, are the journalists who are saying that, because they're the ones who can't tell the difference between a Jamaican and a Gungan. The absurdity of this particular thing is that some gay people think Jar Jar is a gay stereotype, and certain white journalists think that he's a Jamaican stereotype, but Jamaicans certainly don't think he's a Jamaican stereotype. I mean, he's *orange,* and he's clumsy in the same way that Buster Keaton, Jerry Lewis or Jim Carrey is. He's a comic orange amphibian stereotype!

It's the same with Watto or the Neimoidians. The Neimoidians have a Transylvanian accent. And Watto's accent is more like an Italian accent — it's not a *real* Italian accent, but it certainly isn't anything anti-Semitic. It's not even close to being an Israeli or Arab accent or anything else! It's so absurd! We were building characters. *All* characters are built that way, in all of cinema.

When you're creating a character, you're creating somebody with human personality — otherwise, people aren't going to be interested. You are fashioning characters out of some kind of human personality traits, and a lot of people speak with accents. Yoda speaks with an accent, some people in the films speak with British accents, some with American accents, and some with Norwegian accents. We've done that in all of the movies, and nobody seemed to notice, except with this one — which is just bizarre.

Do you think the relationships between directors and cinematographers is going to change in the digital age? For example, will it still be important to light the actors and the sets properly, and to get everything just right?

Lucas: Oh yeah! The camera's still extremely important. It's just that now, there are a lot more resources available to fix things if they aren't quite right, to extend "magic hour" if you want to, or to design the look of the film more meticulously than before. As cameramen get more into the digital age, they will find that the essence of what they do — which is to frame a shot and to make sure the lighting is beautiful or appropriate — will always remain the same.

It's just like acting. It takes a very unique kind of talent to pull off a great performance, and a computer can't do that. You therefore need actors, either in the form of professional actors or animators, who understand how to turn in a performance. It's the same thing for a cameraman. What is a beautiful shot? What is good framing and how do you follow the action? Those kinds of things are still valid — or even *more* valid, because sometimes you can't rely on existing conditions. It's more like old-fashioned cinematography from the Thirties, when [motion picture photography] was a much more studied kind of craft than just going out, standing up against the sun and saying, 'That's my backlight and now I'm going to put a little fill in.' That works to a point, but sometimes you have to do it without the sun, so it's more like creating a look from scratch. You can have *much* more control than was possible in the past.

But it seems that framing and other techniques won't matter as much, because you can alter those things later on if you want.

Lucas: You *can* alter them, but

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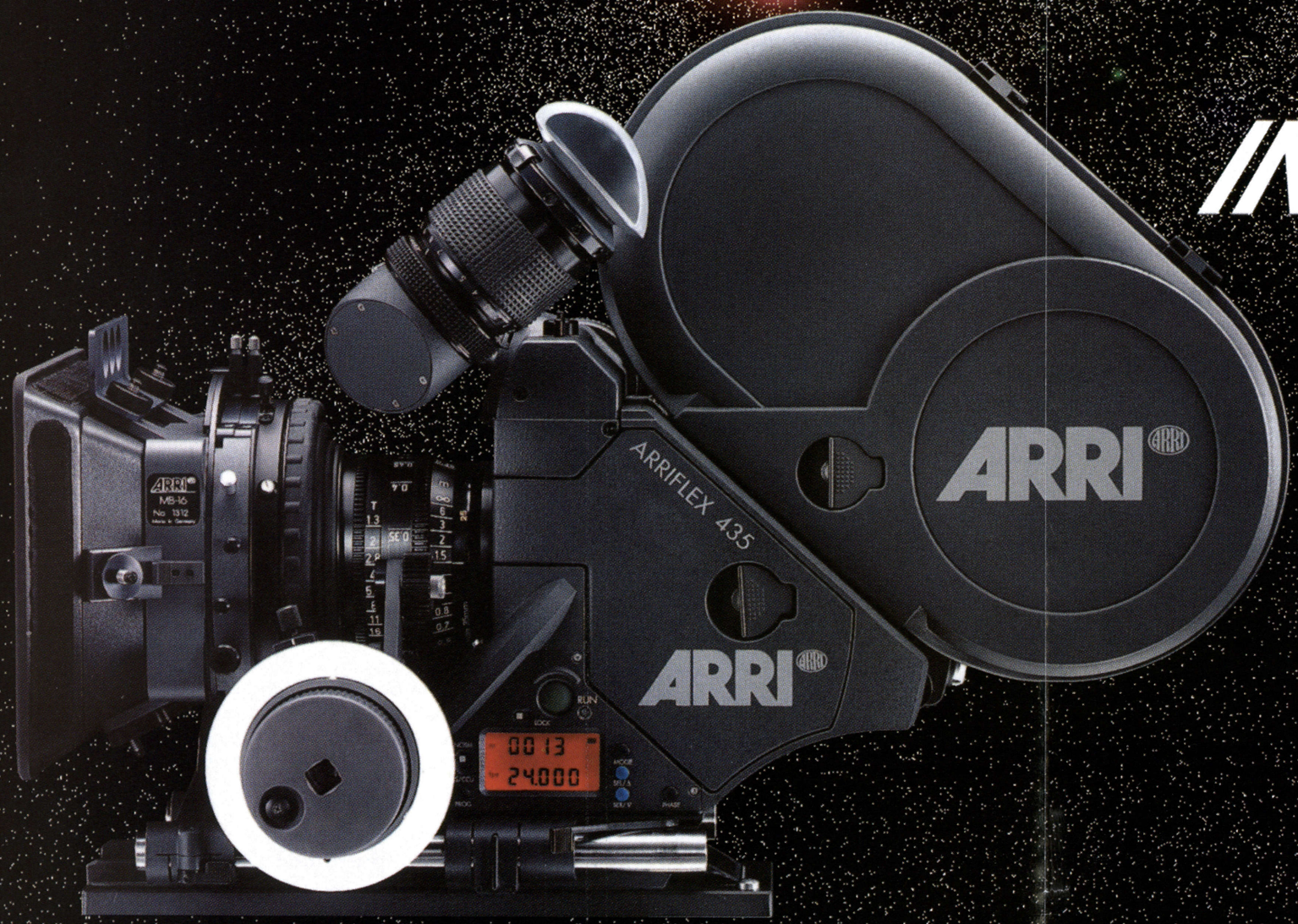

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Master of His Universe

somebody has to decide what that framing is going to be, and the art of the frame still has to be determined. In a lot of cases, the director determines that, but in a lot of other cases, the cameraman determines it. If you've got a situation where the director doesn't feel comfortable making those decisions, the cameraman is still going to have to do it. Instead of doing it on-set, though, the cinematographer is going to have to come in afterwards and confirm the framing on all of the shots to make sure that it looks as good as the director wanted.

Aesthetic decisions still have to be made, and the fact that you can change things later just gives you more freedom. You can come back the next day and say, 'After seeing the sequence, I think we would have been better off if we were in 10 percent [closer] on this shot.' Or, if you want to pull back or move the characters over a little bit, you can rearrange things. Movies are shot in an unlimited number of impossible conditions, and you don't always have the control over the situation that you'd hoped to have. Sometimes people don't quite hit their marks, or the lighting isn't quite right, or you have two or three cameras and one of them wasn't framed up like you thought it was when you walked away from it. Now you can adjust all of that, and you don't have to live with mistakes.

Did your cinematographer, David Tattersall, look at all of the shots you were recompositing on *The Phantom Menace* to ensure visual continuity?

Lucas: He checked in from time to time just to see what we were doing. There are a wide number of ways in which creative people work. There are directors who just want to direct the actors, and they trust the cameraman to [compose the shots]. On the other hand, you've also got directors like Stanley Kubrick, who make all of the decisions. Over in England, where I work most of the time, the operator makes the framing decisions and the cinematographer makes the lighting decisions. Still, most cameramen who are hired onto a picture know what's expected of them before they start, so usually that isn't an issue.

Do you think this is the way that all films will be made in the future? Or is the 'digital backlot' going to be an exclusive club for directors like yourself, James Cameron, Steven Spielberg and Robert Zemeckis?

Lucas: Any director who wants to will be doing it this way. I think there are already a lot of independent film directors working digitally. It's coming from the bottom up, and there are a few of us on the topside that are using it. I assume it'll start moving into the middle.

Do you really think that doing post-camera moves or creating post environments will become so cost-effective that even independent filmmakers can use it?

Lucas: Sure. On the *Young Indiana Jones* TV series, we would do over 100 of these shots in every *hour* — about 200 for every feature-length show — for less than $200,000. That's cost-effective. Obviously, the resolution wasn't very high, but we're reaching a point now where, if you shoot digitally, you can practically use a Macintosh and get an image at a resolution high enough to make it look good on the big screen. If a film is shot digitally and projected digitally, it's very easy to manipulate it digitally. And again, it's very, very cost-effective.

Will the concept of 'fixing' a movie in postproduction lead filmmakers to create films that are less carefully thought-out and more expensive? Or will they really make better films?

Lucas: I don't know. More than anything else, it gives the director, the cinematographer and the art director a lot more freedom to design the look of a movie, and to rethink the movie during the process of making it. It's almost impossible to lay down a blueprint of a movie, then follow it religiously and come out with anything that's really exceptional, as far as I'm concerned. Hitchcock did it, and obviously he made some very exceptional movies, but things have changed considerably since he was making movies, and I think that being able to *work* your movie — to adjust it, change it and massage it — is becoming more and more necessary.

You intend to shoot the next two *Star Wars* films digitally, but Sony and Panavision are still working on the cameras and lenses. At what point will you feel that this digital equipment is good enough to shoot the picture?

Lucas: Well, we're going to test it, hopefully in the fall. They're supposed to deliver the first camera in October, so we'll have from October to June to test it. Obviously, if it doesn't work, we'll seek an alternative, but right now, I have every confidence that Sony and Panavision will be able to pull it off.

Will the next *Star Wars* film will have its own kind of digital look, or will you aspire to a 'filmic' look that's identical to what you've created in *The Phantom Menace*?

Lucas: I'm thinking of all of the *Star Wars* films as one [continuous] film, so I'm going to try to make the look consistent, although I have allowed some variation into the process. We've used different cameramen and directors along the way, so the cinematography in the films is slightly different, with different feels, but it's not a wide range. I think that it will stay that way for the next two films, so all six will have a continuity of look. I'm sure that the electronic look won't be exactly the same as the film look, although [judging by] the tests we've done, it looks pretty close. In *Phantom Menace,* there are some things that I

think are a bit too contrasty; I could go through [the picture] and see what one would consider to be digital artifacting of one form or another, and I would love to see that improved! But I don't think that most people who see the movie can really tell the difference between it and the original *Star Wars* pictures, in terms of the look and feel.

If filmmaking and projection were all digital, would all production convert from 24 fps to a 30 fps, video-based system?

Lucas: In the wider range of possibilities, once film is gone, it's very plausible and realistic to assume that you could determine your own frame rate. You could say, 'I want this one done at 60 frames,' and then shoot it at 60 and project it at 60.

But obviously, in a *Star Wars* film, that could get very expensive for shots with visual effects.

Lucas: Well, yeah. People make those decisions for various reasons, and some of them are cost-related. But the [idea] of a digital shoot at high speeds like that is not that much of an issue. The biggest problem now with digital is that it's probably going to take awhile for it to cover the more esoteric aspects of cinematography, which really have to do with high-speed photography. When you get into the really high-speed stuff, the digital world hasn't quite caught up yet.

I think the ultimate issue here is that, in terms of the photochemical process, we're at pretty much the top of the curve. I know some people would disagree and say that they've got a long way to go scientifically to create a better process, but my feeling is we're really banging up against the high-end of the [film] medium, pretty close to the top. Whereas, in digital photography, which I now think can compare with the photochemical process, we're at the very *bottom* of the technology. This is as bad as it's ever going to be, and from that point of view, the ability to go

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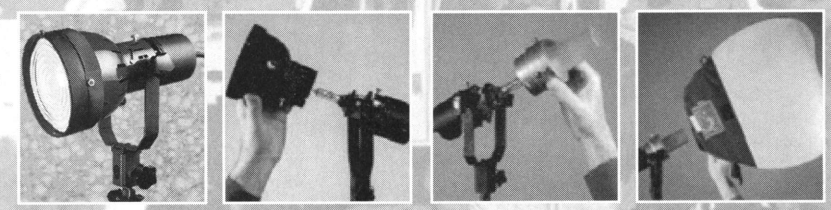

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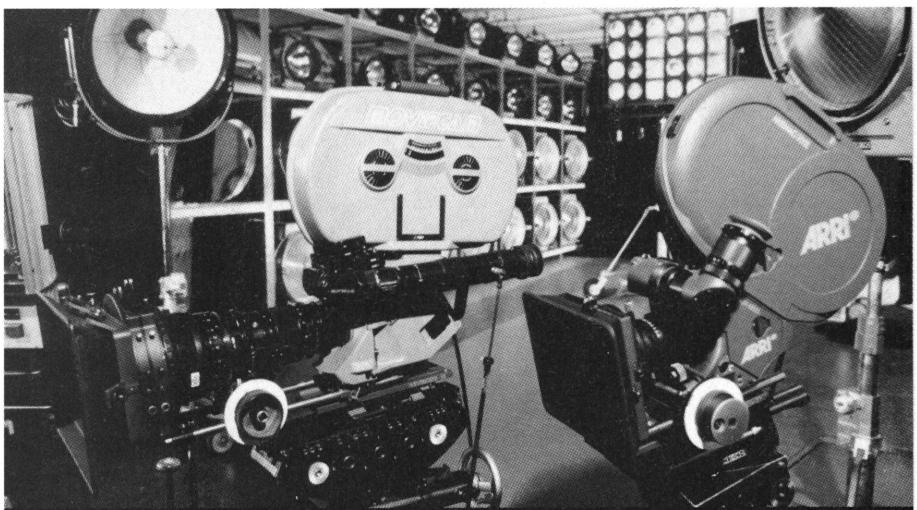

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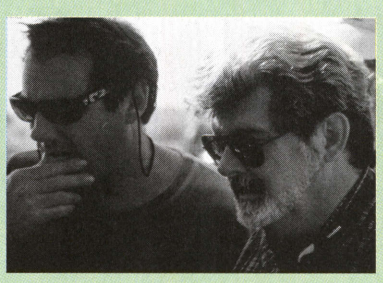
PRODUCING EPISODE I

Phantom Menace producer Rick McCallum sees the future of filmmaking.

by Ron Magid



McCallum and Lucas ponder their next move while filming *The Phantom Menace.*

Rick McCallum has produced George Lucas's *Young Indiana Jones* TV series, the feature *Radioland Murders*, the *Star Wars* Special Editions, and *The Phantom Menace*. He recently spoke with *AC* to discuss the advantages of digital filmmaking.

***American Cinematographer:* Since you managed to accomplish so much with digital and miniature sets on *Episode I*, why shoot on location?**

McCallum: Number one, it's fun, and number two, we wouldn't get the same atmosphere on a backlot — the same kind of light, the same sweat. You can also get more for your money. In Tunisia, we worked with a local crew, so it was very cost-effective for us to go there rather than build sets in London, which is 10 times more expensive than Tunisia.

***Episode I* proved that everything can be modified and fixed after the fact. How does that affect the traditional producer's role, which often involves reining in costs?**

McCallum: Digital technology has reached a point where virtually anything can be done, so producers are no longer in a position where they can't solve a problem. Before, the technology was kind of there, but we still couldn't use it without outrageous expense. Now there's a way to be fiscally responsible and do things at a reasonable price.

We also structured our production schedule differently. For us, it was a nonlinear process. We weren't shooting for 25 to 30 weeks; we shot for 65 days. That was our limit, which meant that we were shooting 36 setups a day, for a total of around 2,500 setups with both the first and second units. On *Phantom Menace*, we also had to schedule our talent so they were available for four months after principal production [for reshoots]. We also tried shooting in warehouse spaces [at Leavesden Studios]. That could be difficult, but it also meant that we could keep our sets up for a year afterwards — at half the cost of being in a traditional studio for three months.

All we're trying to do is create an illusion, often for a shot that lasts just three or four seconds. If somebody else can do something for $100,000 and we can do it for $10,000, and the illusion is exactly the same, that's what being creative is all about. The trouble now with Hollywood is if somebody does something for $100,000, the next person wants to do it for $150,000! People are obsessed with making things bigger!

After finishing the Special Editions, you told me that you could make *Episode I* for $70 million, possibly less. How did the budget escalate?

McCallum: When we had that conversation, I was talking about what I felt were the production costs of the movie — not the digital costs. I don't think we even had Jar Jar Binks at that particular moment in time. Two years ago, I was scared to death that we were going to be talking about $100 million just in effects costs, because at that time, creating a digital character who was going to be onscreen for 90 minutes was going to cost twice Tom Cruise's salary.

When we finally did budget *Phantom*, our estimates came in at $120 million, so we were incredibly happy that we brought the finished film in for around $114.9 million. Working with a very small crew and our cast, we were able to shoot the film for just over $50 million; the balance of the cost was our effects budget, which we will get further and further south. By *Episode II*, we're trying to break the $99.9 million dollar barrier, and for *Episode III*, we're hoping to get down to $89 million, if not $85 million.

You were also hoping to shoot *Episode I* digitally. Obviously that didn't happen. Did that idea increase the potential cost?

McCallum: Not at all. But by the time we finished, we had anywhere from 2,000 to 2,500 shots in the movie. Since they all had digital effects in them, it seemed ludicrous for us to work in an analog medium. It was a waste of time for a bunch of reasons — most importantly, because we wanted to be able to manipulate the image within the context of a single frame, not just a sequence. That's why we want use digital cinematography. There are also a bunch of other issues at stake now for anybody who makes a movie, including digital distribution.

Some people think it's a tragedy that we're moving from a photographic medium into a digital medium, which will allow us to completely manipulate the image. But the further cameramen get into this idea, and the more they understand the technology, the more they will understand that they can now fully manipulate their images to be as strong as they can possibly be. ■

upwards and bring higher quality and more versatility to digital photography is enormous.

I understand that the shot where Qui-Gon draws Anakin's blood was shot digitally. Was that scene treated any differently than those shot on film for digital presentation in the test markets?

Lucas: No, it wasn't. We've done the digital projection tests in the worst possible scenario. [See sidebar on page 70 for details.] We took the *negative* and then we converted the negative back to tape, as opposed to what we're probably going to do in the future, and what [Pixar] did with *A Bug's Life* — which is to reconstruct a digital master from our digital work tapes. The cost of doing that for our experiment, which is basically what those demos in the four theaters were, just wasn't worth it. Besides, we wanted to show the film under the *worst* possible conditions. This is as *bad* as it's going to look. If we transferred it directly digitally and didn't go to film — if we just went right from shooting — the copy would look much better on digital, because the film is 100 percent digital.

Of course, there are questions like 'Will we have to treat [digital] slightly differently?' But even now, we had to treat [those images] in a way, to make them look more like film. At ILM, we're developing software that can re-create different kinds of film looks in terms of color quality, and we've developed grain programs and all kind of things to give digital [images], which are very sharp, more of a filmic quality. However, I think there's going to be a change in the look that will slowly become more and more acceptable as time goes on.

A lot of [this new look] is the kind of things that cinematographers like. We're going to see greater deep-focus photography, which has been a struggle at this point because of the nature of film stock. Way back when, [one of my mentors,] Haskell Wexler [ASC], especially loved deep-focus, and so did a lot of others, especially the black-and-white photographers. They loved to be able to get everything sharp for literally a mile, and you just don't see that too much today. It's just too hard to do it. I mean, you can, but the amount of light you need to pull that off is enormous. With digital technology, it's much easier. People are really going to be figuring out ways to limit depth of field and a lot of other things to make digital have the same kinds of qualities that film has. A lot of it has to do with the lenses, and I think that Panavision, for example, is ultimately rethinking their whole process. I think you're going to end up with a different variety of lenses. [See page 28.]

If you shoot the next *Star Wars* film digitally, will you create a film master as a preservation copy?

Lucas: No.

Is digital technology stable enough to preserve your film?

Lucas: I think it's as stable as film. Now, in terms of the next movie, there *will* be a film copy, because it has to be *shown* on film. For the immediate future, we're going to still cope with film. No matter what you do, you're going to *have* to make a negative, [because] you're going to *have* to release it somewhere in the world — or in some theaters — on film! It's going to take a while for all theaters to convert over. At some point in the future, there probably won't be any more film. Still, that's going to take somewhere between 10 and 20 years.

[Meanwhile,] the preservation technology for digital is improving all the time. A lot of companies realize that they can make a fortune if they can crack the archival problems that now exist. Personally, I have faith that it will happen. ■

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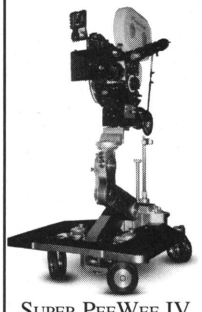

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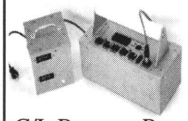

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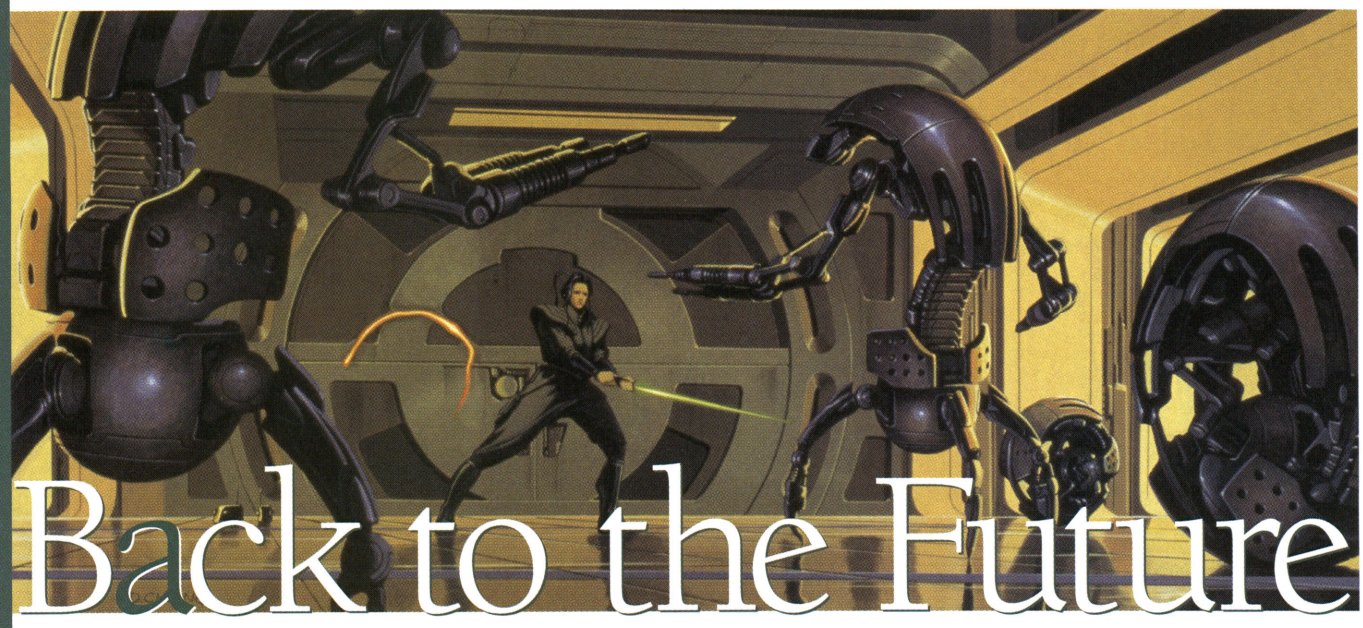

Back to the Future

Art director Doug Chiang and production designer Gavin Bocquet conjure up dazzling new worlds and environments for *The Phantom Menace.*

by Stephen Pizzello

Unit photography by Keith Hamshere, Giles Keyte and Jonathan Fisher

A *longer* time ago, in a galaxy far, far away — as George Lucas reveals in *The Phantom Menace* — the seeds of young Anakin Skywalker's transformation into the malevolent Darth Vader were sown during an intergalactic trade dispute revolving around the peaceful planet of Naboo. This seemingly mundane political conflict was eventually revealed to be a grand Machiavellian maneuver that sparked a full-scale showdown between the forces of good and evil, staged in a variety of spectacular settings.

In crafting this elaborate backstory for his wildly successful *Star Wars* franchise, Lucas set forth a daunting job for himself and the film's visual design team: to create new characters, vistas, weapons and vehicles that would meet the fanatical standards of the epic fantasy's legion of loyalists. Helping Lucas to tackle the monumental task were art director Doug Chiang and production designer Gavin Bocquet, who worked closely with the director and each other to reimagine the *Star Wars* universe.

The Force was with them

Chiang's appointment as the film's art director capped a seemingly predestined career trajectory launched during his youth in Michigan, when he became enamored of science-fiction in general and *Star Wars* in particular. Dazzled by the picture's visual grandeur, he began studying the work of its expert conceptual designers, Joe Johnston and Ralph McQuarrie. The budding artist developed his skills on his own, raiding local libraries and learning techniques that had been mastered by Johnston, McQuarrie and fellow futurists Syd Mead and Ron Cobb. "One of the things that really fascinated me was combining mechanical forms with nature, so I was very fond of industrial designers," Chiang relates. "I tend to lean toward mechanical shapes because they come easier to me. At the same time, I was also fond of landscape painters like Albert Bierstadt. I really wanted to combine the two disciplines of industrial design and landscape painting, so I began placing unusual technology into nature scenes. Because I was really interested in animals, I also became very intrigued with wildlife painters, and I gravitated toward painters like Robert Bateman and Raymond Harris-Ching. I thought the techniques that wildlife painters used were very similar in some ways to what Ralph McQuarrie was doing.

"Most of the people I admired worked in acrylic, and it was a medium that I was comfortable with at that time, so everything began to merge together. Acrylic is easy to buy, and it works well for my painting style because it's a tough medium; I like to really work things over and over. It's probably not the best medium for what I do, though; some other artists I'm familiar with use cel vinyl, which cel animators use to paint their backgrounds. It's an

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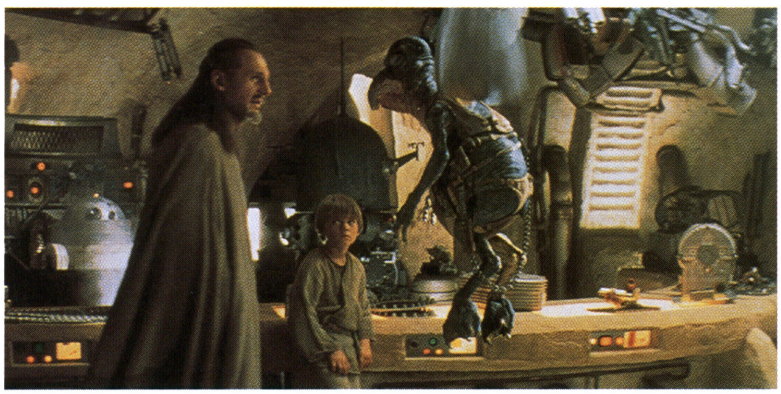
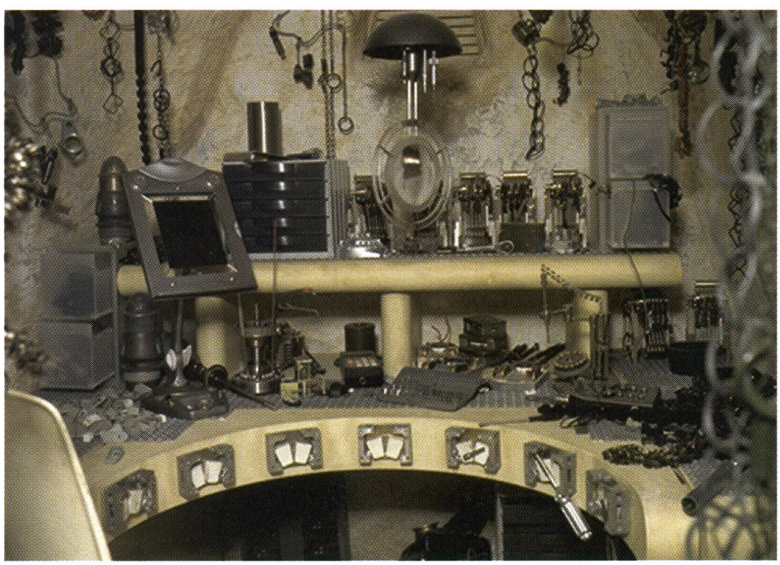
acrylic-based medium, but it has some of the characteristics of gouache, and it's very opaque. It's a very quick medium, but since I never really had a formal art background, acrylic was the only thing I'd really been exposed to. It took me this long to get comfortable with acrylic, so now I don't want to switch!"

After honing his skills during high school, Chiang headed off to Los Angeles to attend UCLA, where he began drawing storyboards for motion pictures. Following his graduation, he tried his hand at stop-motion animation for a computer-graphics company called Digital Productions, where he also designed and directed television commercials. That experience led to a stint on the popular children's TV show *Pee Wee's Playhouse,* for which Chiang animated the amusing residents of Pee Wee Herman's refrigerator. He later moved on after a former co-worker at Digital Productions, Steve Beck — who had become head of the art department at Industrial Light & Magic — invited him to work on a three-week project at the northern California effects empire. That particular job never came together, but ILM kept feeding Chiang work, and he eventually served as a visual effects art director the films *Ghost, Terminator 2* and *Death Becomes Her.*

Chiang's first assignments at ILM eventually led to his big break when he heard through the grapevine that George Lucas was starting work on *The Phantom Menace* and wanted to staff up the art department. "Everyone I knew put together a portfolio," he recalls. "Luckily, I was prepared, because I'd been working on one of my own that featured production paintings, some stop-motion work, digital matte paintings, storyboards and a lot of my personal paintings of wildlife and technology. I sent the portfolio up to Skywalker Ranch, and [producer] Rick McCallum called me the following week to set up an interview. Rick and I had a very casual, friendly chat, and at the end of it he asked me, 'Well, how would you like to be in charge of the art department?' He kind of caught me by surprise — but naturally I accepted the offer!"

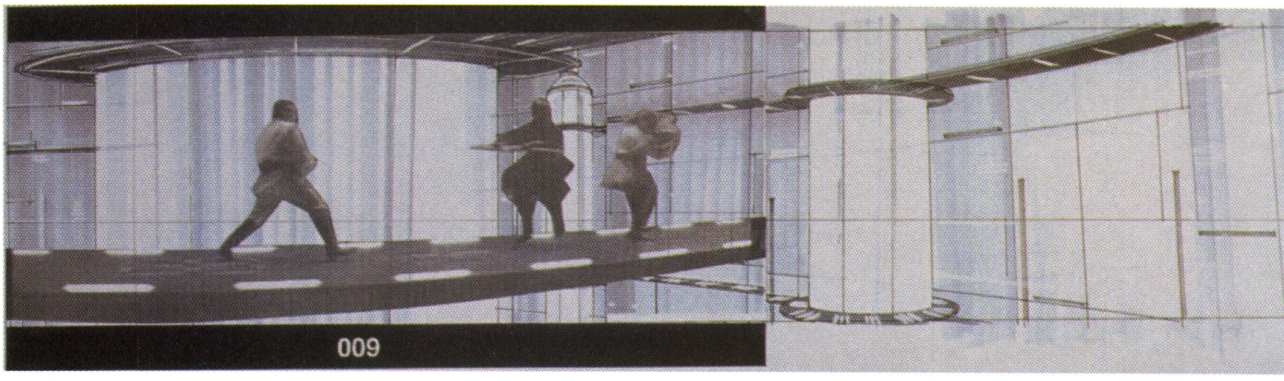




Opposite: In one of Doug Chiang's conceptual paintings, a lone Jedi confronts an array of Destroyer Droids. Chiang notes that Lucas wanted the Destroyers to be "fierce and no-nonsense, like walking pairs of guns." The artist based his designs on insects and spiders, and gave the Destroyers three legs to make them look "really interesting and otherworldly." This page, top to bottom: an exterior in the Mos Espa marketplace; the interior of Watto's shop; Anakin's workspace. Gavin Bocquet's production design team combined real locations in Tunisia with carefully detailed sets filled with items devised by prop department head Ty Teiger and set decorator Peter Walpole.

Gavin Bocquet, the film's production designer, had also worked within the Lucas empire before landing his job on *The Phantom Menace.* After studying at the Royal College of Art in London, he met respected British production designer Stuart Craig, who gave him a job on the 1980 sci-fi film *Saturn 3.* "My official title on that film was 'space equipment devisor,'" Bocquet recalls with a chuckle. "I designed some of the control panels and

Back to the Future



Qui-Gon Jinn and Obi-Wan Kenobi battle Darth Maul in the Generator Room. Chiang recalls, "George wanted some kind of huge energy room to serve as the backdrop for this incredible fight in the foreground, and he wanted to incorporate a bottomless pit. We were trying to go for scale and energy, and we were trying to contrast the different types of energies — the lightsabers versus these huge vertical cores. George really only specified that it had to be a powerful, mysterious environment, a moody place that felt a bit like the inside of a Tesla coil. He also wanted a space where he could stage the fight in three dimensions, so the Jedi could be jumping from one catwalk to another. That really dictated the vertical aspect of the design."

props. I've always enjoyed science fiction, and it can certainly be very interesting in terms of production design. As long as you have a good story that demands good design, though, it doesn't matter which genre you're working in. To me, *Star Wars* is really just a period drama that happens to be set in space."

After his experience on *Saturn 3,* Bocquet joined Craig's department on *The Elephant Man,* directed by David Lynch. He was subsequently hired to work on *Return of the Jedi* by production designer Norman Reynolds. Bocquet's first feature film as a production designer in his own right was Steven Soderbergh's *Kafka;* he was later recruited by producer Rick McCallum to work on the *Young Indiana Jones* television series. "That was my initial connection with Lucasfilm," he says. "Although they didn't say so, I think George and Rick were trying to gather a group of technicians who could possibly move on to *The Phantom Menace.* Three of four years later, George realized that digital technology was becoming much more flexible and cost-efficient. Some of the effects techniques we used on *Young Indy* were later pushed through to [the Lucas-produced feature] *Radioland Murders,* and were then expanded to a much bigger scale for *The Phantom Menace.* I think *Young Indy* was the first drama that took those processes and applied them to invisible images, in the sense that the audience would not really realize that anything had been done to the images — the work was meant to be very naturalistic. George was very keen to get those costs down, in terms of not being too precious about what we did, but knowing that maybe nine out of 10 times we could make the shot work at ILM. I think he felt that if he could deal with that sort of theory on his bigger-scale projects, it would be financially viable to do the *Star Wars* prequels."

Both Chiang and Bocquet admit that they found the sheer magnitude of *Episode I,* in terms of both the work and fan expectations, a bit intimidating. "For the first couple of months I tried not to think about it," Chang admits, "because if I did I just froze up and couldn't draw. This job was what I'd always wanted to do, and it was the main reason I'd gotten into this field; in some ways, I'd been preparing for it ever since I'd seen the first *Star Wars* movie. In other ways, the enormity of the task is something you can't really prepare for, because working with someone like George is kind of like a dream. Knowing that he'll be critiquing every line you draw can be a frightening thought!"

Bocquet offers, "In the end, you have to trust that somebody has employed you to do a job because they have faith in you. Everyone working on a film has a mixture of insecure and confident impulses, but the work you do is almost on a day-to-day, week-to-week, month-to-month basis. You don't think so much about the project as one big thing. You have certain schedules and certain problems to solve, and you work at those very methodically. Generally, it was only when I came back home in the evening, or when I was talking to friends, that I heard 'How can you possibly do that? That's huge, that's enormous!' When I was outside the work environment, the scale became more apparent, and I thought to myself, 'Ooh, I suppose it is quite a big job!' In the end, your day-to-day problems become a series of pages that you turn — until finally, one day, you're finished!"

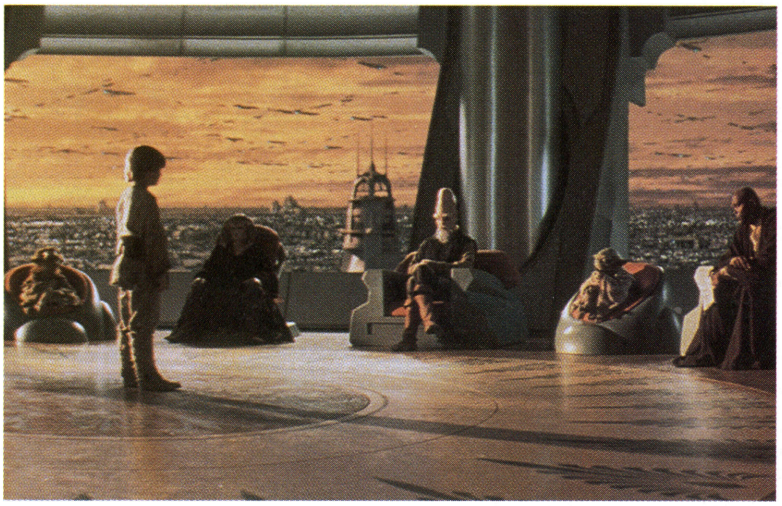
At the drawing board

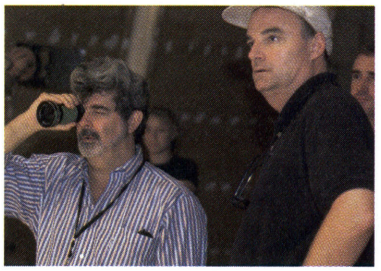
The design work on *Phantom Menace* began with Chiang's conceptual drawings, which were based on Lucas's imaginative ideas. The artist says that working for Lucas was a virtual seminar in motion picture aesthetics. "The format's the same in terms of the design of your composition, or your 'aspect ratio,'" he notes. "What defines the difference for me — and this is something I learned from George — is that film is about story, and the visual designs you create have to help the story. You can't really distract from the story by creating something that's so complicated and intricate that the viewer starts to ask questions about it, like 'What's that all about?' and 'What does it do?' During prep for *Phantom Menace,* we would present all of our artwork on a wall, and George would literally walk in, survey this entire

wall of 20 or 30 drawings in about 10 seconds, and pick the three or four that he liked.

"That was really a shock to me, because I'm used presenting each idea and talking about it in depth — 'This works like so' and 'This mechanical joint does this.' George didn't want to hear any explanation; his thinking was that if you can't understand it visually in five seconds, it's not going to work for the film. During the course of the film, these images appear very briefly, and no one is going to be there to explain them — the viewer has to understand them immediately. That really changed the way I drew, because George is a big proponent of thinking in terms of bold concepts and ideas. As a result, the designs have to be very bold: they have to have strong silhouettes and very identifiable features, so that you can understand them on the first glimpse."

Chiang testifies that Lucas himself is an "incredible designer" who provided constant input. "Everything came from George," he maintains. "I still have the notes from the first meeting that we had, and a lot of the elements changed very little. For example, he described the podrace exactly as it appears in the finished film. Even though we explored other avenues, it always came back to George's vision. Sometimes he'd be very specific to the point where he would actually pick up a pencil and doodle a bit on the sketch itself, adding things here and placing things there. At other times, he'd look at two drawings and say, 'Let's take this part of this drawing and combine it with that one.' He puts the designs together visually, almost the way an editor would — combining the pictures and strengthening the concept. A lot of times he would combine elements that at first seemed impossible; I'd think, 'Wow, this is going to be a really tough challenge.' But I think some of the best designs emerged from those moments, because we were forced to think in new ways.



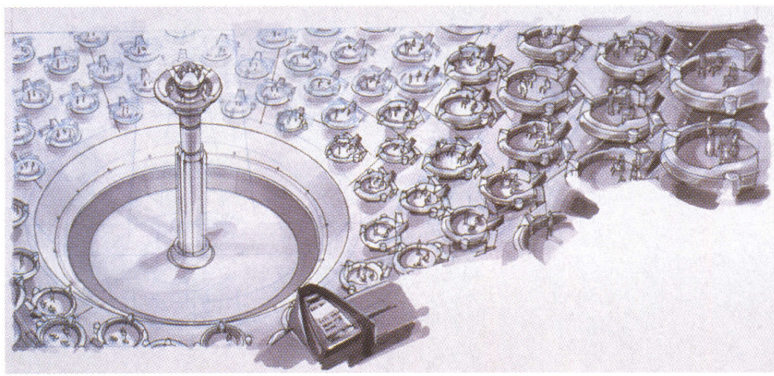


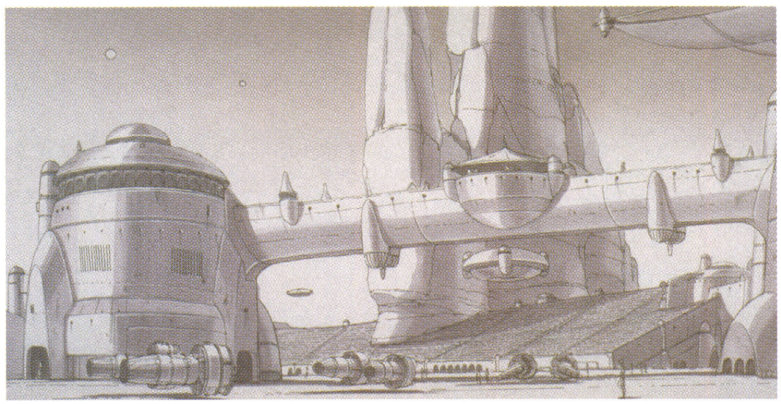
Two views of the Jedi Council Chamber, before and after digital augmentation. Notes Gavin Bocquet, "George's initial idea was that he wanted it to be very much like the reading room of a gentleman's club, with comfortable armchairs. It wasn't really meant to be a regal place, like the Queen's throne room, but more of a discussion room." Bottom left: Doug Chiang examines some artwork with viewpaint supervisor Jean Bolte. Bottom right: Gavin Bocquet observes as George Lucas frames his sets through a viewfinder.

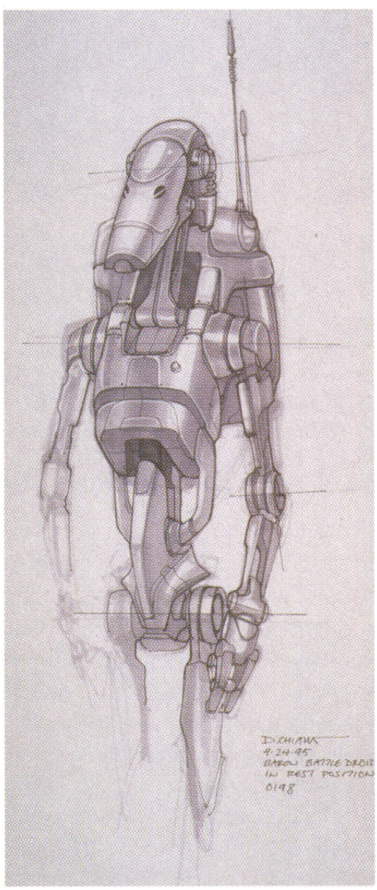
"Watto is a perfect example of that dynamic. George came in one day saying that he needed a new character, and he liked this one portrait that had originally been rejected for one of the other characters. He said, 'Let's use this portrait — put it onto this fat, cherub-like body and add some small hummingbird wings and duck feet.' When you hear that kind of verbal description, you think, 'Hmm, is that really going to work?' You have to trust George, though, and when I drew that combination of weird features, it worked perfectly. Those oddball elements gave personality to Watto. I really don't know where he gets his ideas, but they always seem to work.

"George always has a really strong image in his mind, so from my perspective it become a matter of

Back to the Future







Top: The Senate Chamber on Coruscant. Chiang reveals that the scene's floating platforms were originally designed for the podrace sequence. "When George was writing the Senate scene, he said, 'You know, we need to make this more interesting than just a big auditorium.' He suggested, 'Let's take these floating platforms and put them in the Senate, and we'll come up with something else for the podrace.'" Center: The podracing stadium on Tatooine, which Chiang describes as "an organic structure built into the natural surroundings of a desert plateau." Bottom: A Battle Droid stands at the ready. Chiang based the design of these fighting robots on African tribal sculptures, "which stylize human and animal forms into somewhat mechanical shapes."

trying to interpret that image," Chiang concludes. "I think in some ways, I'm literally just George's hand, because he's the mind behind this whole world."

Chiang was assisted on the show by several other helping "hands" — his team included Terryl Whitlach, who handled creature designs and their biological requirements; Ian McCaig, who specialized in human characters and costume designs; Jay Shuster, who offered a strong mechanical sensibility and a flair for graphics; and Ed Natividad, an "all-around talent" who proved particularly adept in architectural design. Chiang notes, "In some ways, each of these artists was brought on the show to design certain things. Given the way we worked in the art department, though, everybody did a little bit of everything — sometimes I might do a costume or creature, and the others jumped around a bit too. We didn't restrict the artists to their own individual specialties."

Naturally, the overall design of *Phantom Menace* had to dovetail with the existing *Star Wars* films, even though the prequel story was set several decades before the 1977 installment, *A New Hope*. Chiang explains, "In approaching this film, I initially found myself trying to be like Joe Johnston and Ralph McQuarrie. Joe is one of the most incredible mechanical designers out there. He has a great sense of what will work visually, in addition to making things look believable, so that it's not a fanciful design; his designs look as if they can function. Ralph's work also has that same quality, but I admired his drawings more for their incredible environments — he created these really epic scenes. I wanted to combine those two disciplines as much as I could, but George guided me away from imitating Joe and Ralph; he told me to try something completely different, because he didn't want to repeat what had been done before. That was very refreshing to hear, because it allowed me to bring a bit more of my personality into the designs.

"*The Phantom Menace* was the furthest from the other films in terms of its time period," he points out. "We equated this world to, say, the early 1900s on Earth, when all of the art forms and everything else was a bit more handcrafted. The designs in *New Hope* are a bit more industrial and assembly-line — not necessarily clunkier, just different. That working philosophy allowed us to create a very rich design aesthetic that was heavily influenced by art nouveau. It was visually intricate, but it still fit into the overall *Star Wars* design philosophy.

"In the original *Star Wars* films, George made it very clear who the bad and the good were, by their forms and their colors — the Imperials had the dark cool greys and the rich reds, while the Rebels had the earthtones and greens, with softer forms. In this film, George wanted to blur that a bit, because the

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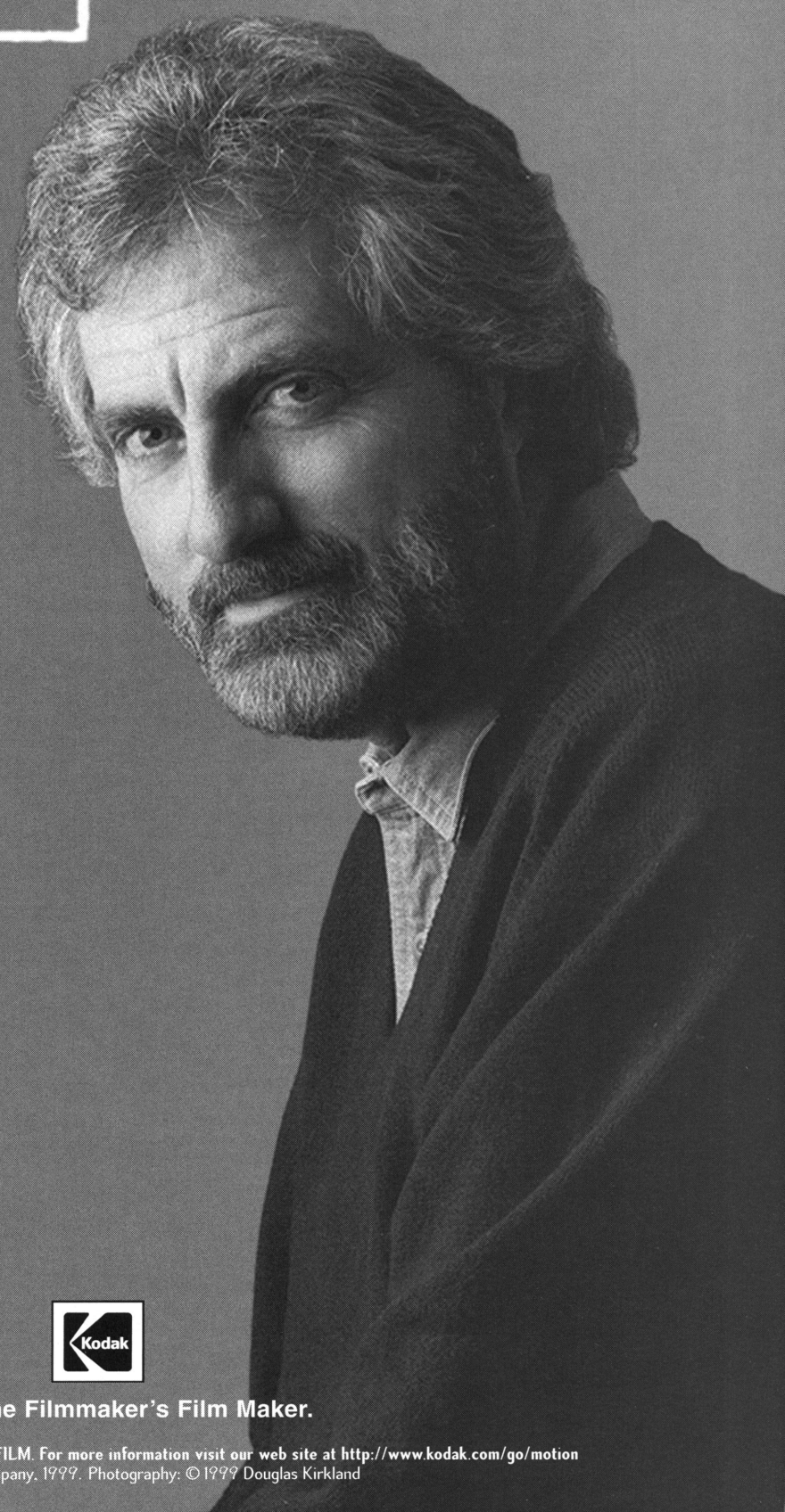

"I was drawn to filmmaking because of its power to tell stories about human drama. I don't think of myself as strictly an IMAX® cameraman, but I do love the large format and am beginning to understand its potential. The big screen immerses the audience into the experience of new places. The possibility exists to extend large format productions into narrative story telling, dealing with dialog and human emotions. The challenge is greater because the medium is more complex, but the opportunities to convey these experiences can be more profound."

Reed Smoot's narrative films include *Homeward Bound: The Incredible Journey*, *The Windwalker*, *Russkies* and *The Long Hot Summer*. He was also a cameraman on *The Great American Cowboy*, an Academy Award® -winning documentary, and such large format films as *Grand Canyon: The Hidden Secrets*, *To Be An Astronaut*, *Yellowstone*, *The Rainbow War*, *The Great American West*, *Olympic Glory*, *Mysteries of Egypt* and *Journey of Man* in 3D.

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Back to the Future

Interiors for the Queen's Palace were shot at Reggia Palace in Caserta, Italy. Bocquet notes, "George wanted monumental scale, with grand corridors and rooms."

evil forces aren't quite as defined yet. For example, the Droid Army has earthtone vehicles with roundish forms. As we progress through the next two films, though, those defining looks will become more clearly delineated."

A team effort

The various worlds visited by the characters in *Phantom Menace* inspired the show's conceptual and production design teams to combine different architectural styles, and to work closely to ensure a seamless blend between the conceptual drawings, digital effects work and practical sets. Bocquet joined the project three or four months after Chiang, and he quickly got a sense of where things were headed. "Doug and his group had just started producing some initial ideas for George," he recalls. "When I arrived, they had gotten about four or five of the key environments sorted out. George knew that he wanted the classical city of Theed on Naboo; he'd also planned to have an underwater city, and to bring the story back to Tatooine. He would usually bring in five or six pages of the script at a time, and we would discuss each section in turn.

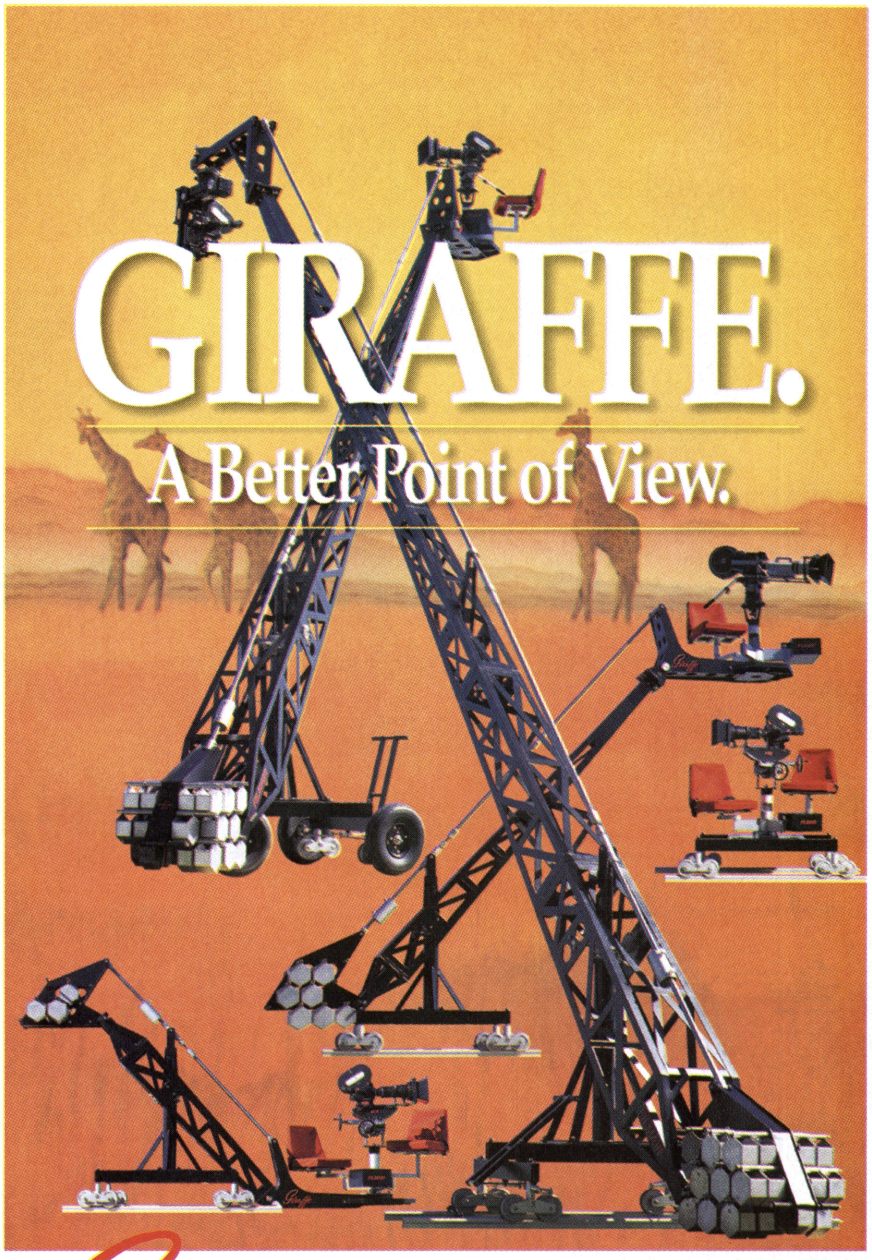
"By the time I came onto the show, there was an idea of which of the sets or locations we would have to design, build or find," Bocquet continues. "In the end, we were dealing with about 60 to 65 environments — a mixture of the sets at Leavesden Studios, and locations in Tunisia and Italy. Leavesden is really an abandoned aerospace facility, but it now has nine soundstages and a huge backlot area, and we took over the whole place. The hangars we worked in were just huge, and we were often building several different sets in each one. Certainly, the location work fell pretty heavily to my team, in terms of finding the settings and locations, and either building or adapting them. Neither Doug nor I had ever worked in that type of situation before, so we tried to separate things out. Overall, I'd say about 20 percent of the sets or locations were designed purely by my group in the U.K. art department; 20 percent were done by Doug and his conceptual team — which we then took to develop into 3-D sets where needed; and the other 60 percent were a collaborative effort, with the two teams handing things back and forth. There was a lot of give-and-take.

"A good example of that teamwork is the Queen's spaceship, with its sleek chrome design. The ship's exterior was designed completely by Doug, but the interior was done entirely by my group. With that ship in particular, George wanted a design

that had the kinds of clean lines you see in older science-fiction films from the Fifties and Sixties, rather than the grungier, sort of techy look that he himself made popular with *Star Wars*. My team had to place various rooms and corridors within the exterior shell that Doug had designed. Of course, it doesn't all work perfectly from a technical perspective — the ship's exterior is probably slightly smaller than the interiors would require in reality, but the spirit of the design is what really matters, and it works well in the film.

"I have to say, when you're dealing with production design for science-fiction films — especially on this type of project, where you're getting creating five different civilizations — the more input you can get from the more creative people, the better. We had anywhere from 20 to 35 people in the U.K. art department at any given time, and Doug had his group. It would be very arrogant to think that Doug and I could create five civilizations' worth of architecture and artifacts by ourselves. That's also why George liked the idea going to Tunisia to use North African architecture as a basis for some of his architecture in Tatooine, or to Italy for the palace scenes. Thousands of architects developed those real pieces of architecture, and the buildings and locations we used have an integrity and realism that the audience can relate to. I think George feels that if he designed those things from scratch, they would basically just look like abstract, completely imaginary environments."

Once the various settings were conceived, the production assembled a construction crew to do the necessary work in England, Tunisia and Italy; at one point, 300 artisans were sawing, painting and hammering away. Bocquet's construction budget was approximately $6 million, a very reasonable sum that he attributes to careful planning: "George and Rick [McCallum] believe in giving their



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people the necessary information as far ahead of time as possible. We had a year and a half of prep to look at every set, decide how much we had to build and how much was going to be added later, and determine how much George would shoot on each set. Generally, he preferred shooting the majority of the backgrounds for real on the sets. Digital work can be extraordinarily effective, but let's not forget that it can also be very expensive. In general, it's often easier and cheaper to build another 30 or 40 feet of wall than it is to add that extra section of wall with 10 digital shots."

The Queen and her court

One of the film's most important settings was the Queen's Palace on Naboo, and the surrounding city of Theed. Set amid a lush, verdant landscape, the royal enclave reflects the planet's pleasant, tranquil ambience. "In our initial discussions, George described Naboo as an idyllic paradise with very old architecture that combined different styles," Chiang relates. "I collected architectural references from various periods and then showed them to George, who began editing them down to the building styles he liked.

"Once we got all of that information together, we began designing new buildings using those forms. We equated the Queen's realm to Venice, Italy, which is like a merchant city that combines a lot of different cultures and architectural styles. Venice is very old but somehow timeless place, which is the quality that George wanted for Naboo. In addition to Venice, I referenced a lot of Moroccan buildings, as well as the Blue Mosque in Turkey, and began combining some of those ideas in unusual ways — like taking the domed roof from one building and putting it onto another. The process involved a lot of mixing and matching, as well as changing the scale a great deal. That worked very well, because it created a unique, timeless

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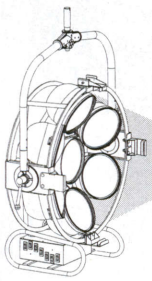

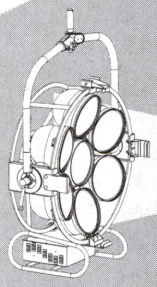

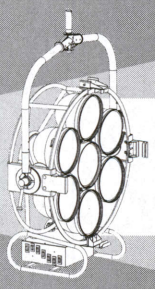

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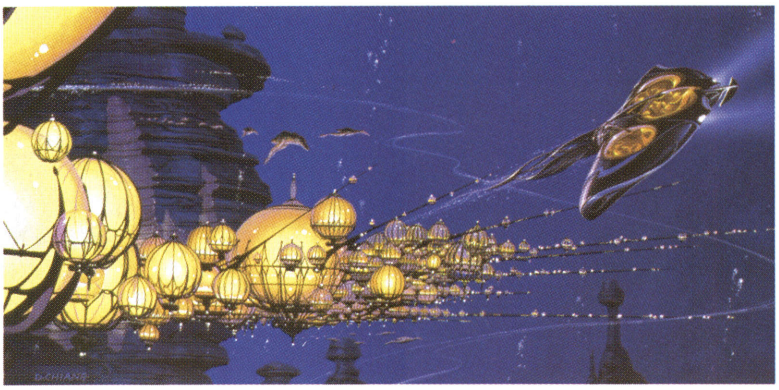

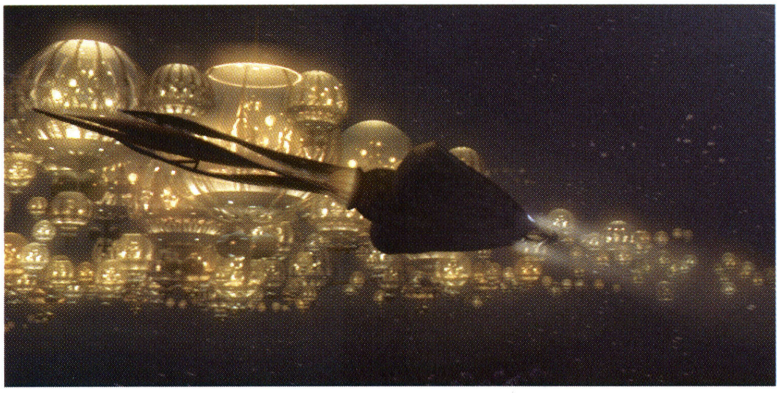

The Gungans' aquatic realm, shown in both a conceptual painting and a finished frame from the film. Says Chiang, "George had always described the Gungan civilization as a world of bubbles, almost like an underwater chandelier — very sparkly and magical."

kind of architecture that wasn't so fanciful that it was unbelievable. Once we had the architectural style down, George had us go in and add things like high-tech doors and chrome handrails to take the look into another realm."

Theed's exteriors, such as its main plaza, were shot at Leavesden, which offers one of the world's largest backlots, an area totalling over 100 square acres. Bocquet details, "The plaza set wasn't meant to be shot as one big area; it was meant to be used for little pieces of action that would later be augmented with wider shots featuring huge digital additions. We built about 20 to 30 buildings for the plaza. One skill you bring to bear in that type of situation, from a production designer's point of view, is to provide as many angles as possible from many different positions, so that onscreen, what you've built looks three or four times

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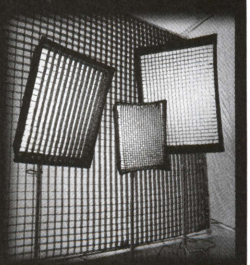

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as big as it really is."

While the exterior of the Queen's Palace was created digitally, the interiors were filmed at Reggia Palace, a majestic structure located in Caserta, Italy. Naturally, the production had to be quite mindful of the sacred structure, and any scenes involving action or explosions were shot on separate sets built at Leavesden. "We had to be very careful in the real palace," Bocquet confirms. "We installed the high-tech doors you see in the Queen's throne room at the real location, but we used very soft wedges and put things up very delicately. Basically,everything had to be pressure-fitted. For example, we we put up some chrome door controls with double-sided tape. However, the marble in those buildings is only clad generally, it's not solid marble. It's maybe a quarter of an inch thick, and it's cladded onto a brick and rubble back, so it's pretty weak. When we put this double-sided tape on it, we had to be careful not to tear off a piece of marble that probably hasn't been moved in 2,000 years! Of course, there's a point where you say, 'This isn't worth it. It's cheaper to build a set.' That's a continual thing if you're a production designer working with a director and a producer: deciding how much can or should be done on location."

Throughout the 65-day shoot, Bocquet maintained close contact with cameraman David Tattersall, BSC. "David was very connected to the art department," he confirms. "He took an extremely active interest in what we were doing with colors and light, which is invaluable for a production designer. In my opinion, you can't separate the physical design of a set from the design of the lighting. Wherever possible, those aspects of a production should be totally integrated."

Bocquet concedes that some of the film's huge settings caused unavoidable difficulties. "Certainly, one of David's biggest problems — which we couldn't really avoid — was that we were often building quite large sets that were actually smaller portions of even *more* gigantic spaces. If you've got a setting that's four or five times the height of the portion that you've built, the lighting becomes a difficult undertaking, especially when you consider that David didn't always have the space to get the lights back to where they needed to be. I have to say, one of the great pleasures of the film — for Doug, David and myself — is that the final result looks quite seamless."

The seat of true evil

Another of the detailed new worlds shown in *The Phantom Menace* is Coruscant, which was glimpsed briefly during the inter-

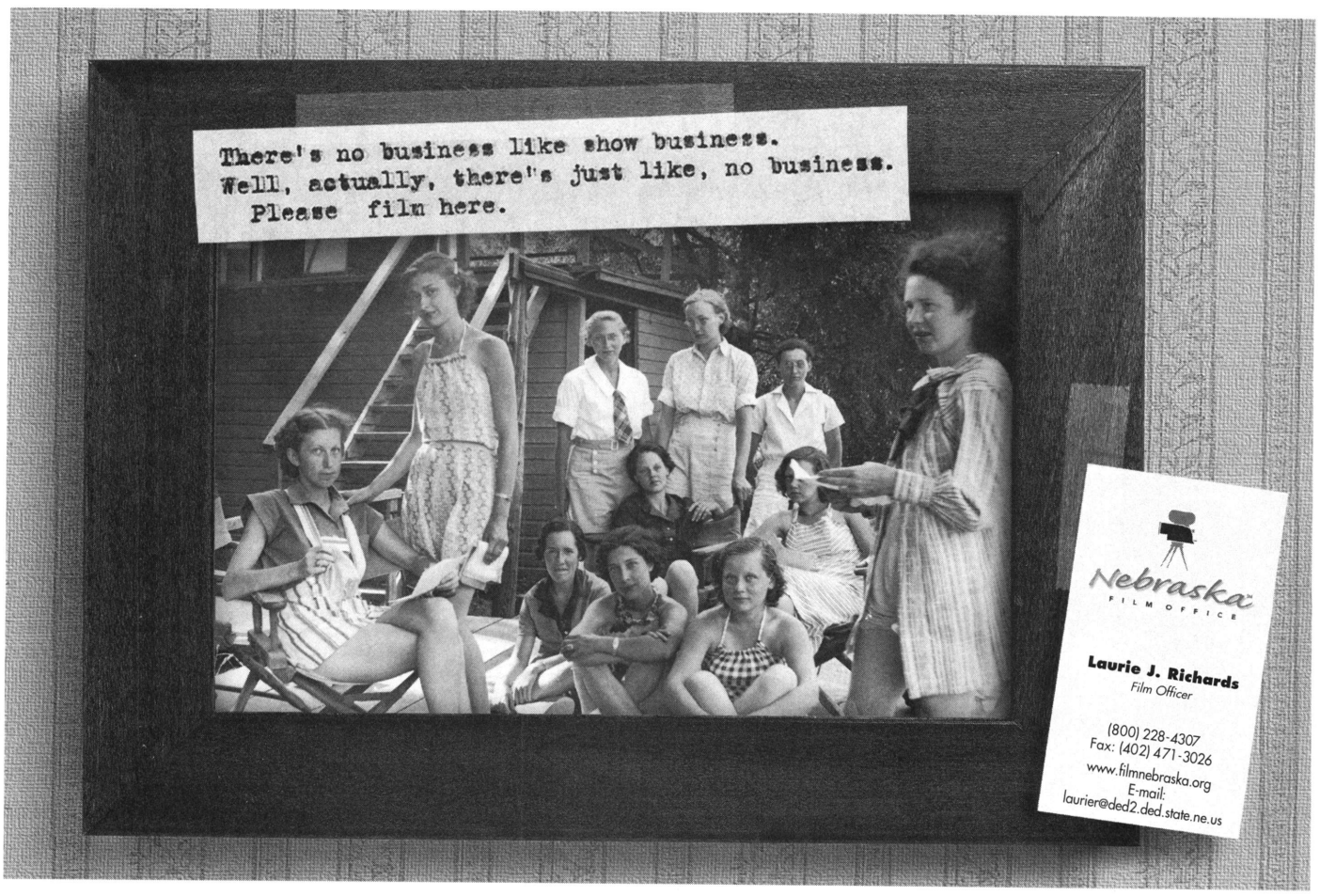
Back to the Future

planetary celebration that now caps the refurbished version of *Return of the Jedi*. "George wanted Coruscant to be a really cosmopolitan place, a planet of buildings thousands of times bigger than what we'd seen before," Chiang relates. "We were going to show a few distinct settings — the landing platform, the Jedi temple, the Senate chamber, and Senator Palpatine's quarters. The landing area and the Senate chamber were designed to be very art moderne, with a mixture of exotic materials, while the Jedi temple was supposed to look older and more monumental. Palpatine's residence, meanwhile, was more like the type of place you might see in Manhattan, with lots of poured concrete and other familiar-looking materials."

For Bocquet, Palpatine's apartment was Coruscant's key set. Since true fans of *Star Wars* already knew that the smooth-talking Senator was destined to become ruler of the evil Empire, Bocquet felt compelled to give his living quarters a unique and suitably regal ambience. He points out that "it's usually an integral part of a production designer's job to deal with characters' backgrounds, and to make sure that the details are right — where they live and how they live. From that standpoint, Palpatine's residence was quite a challenge for me, and also for the set decorator, Peter Walpole — I mean, you're talking about the future Emperor's house! To get it right, we took a very bold approach and did his quarters in deep shades of red — crimson and maroon. George wasn't quite sure about that idea at first; if you think about it, there's never been very much vivid color in the *Star Wars* films, so you're making quite a big statement when you do something like that. Red is a very difficult color to get right on film, so we did a lot of camera tests with David Tattersall to prove to George that it would work without going muddy or black. I was very pleased when I saw the results on film; the color lab, Rank [Deluxe], did a great job, and the reds in Palpatine's place were very true to the colors in our set."

Return to Tatooine

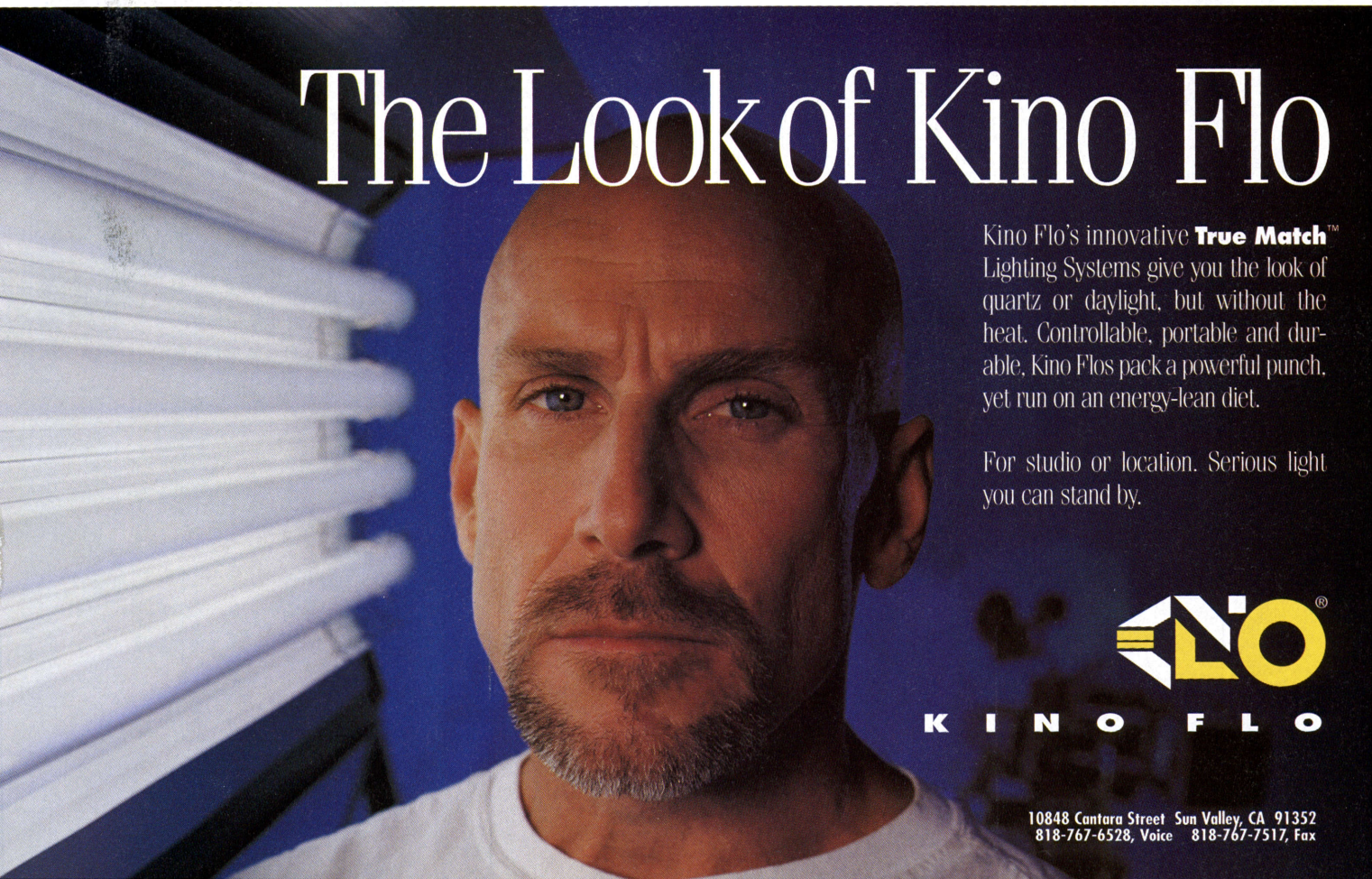
Of course, one of the *Star Wars* saga's most popular settings is Tatooine, the home planet of both the young Anakin Skywalker and his future son, Luke. Chiang notes that since the planet had been already heavily designed in *A New Hope*, "the main goal was to embellish that look and really create another city that fit within the previously established style." The result was Mos Espa, a bustling marketplace where Qui-Gon Jinn first meets Anakin, who toils in a shop owned by the cagey merchant Watto.



The Mos Espa sets were built in the sweltering heat of the Sahara Desert, north of the film's Tunisian production office at the Palm Beach Hotel in Tozeur. At one point, a sudden storm destroyed nearly all of the sets, but the production bore down and rebuilt them so quickly that little time was lost on the schedule. To lend Mos Espa a truly authentic feel, Bocquet and his team hired a group of local laborers to help construct it. "In terms of the look, I think George really wanted to mirror Mos Eisley from *A New Hope*," the designer says. "He'd wanted to show more of that setting, but the technology wasn't quite up to snuff back then. We actually went back to the original site in Tunisia that had been used for Mos Eisley, but it had changed a great deal in 20 years, and we couldn't find that classic old geometric plaster architecture anymore. Instead, we went to the interior of the desert, where we basically built a sort of composite street set. The great advantage of going to a location like that is that you can use so much of the natural dressing. Whether it's food, clothes, or costumes, half of your set can be filled with local wares. Of course, we also enhanced the look with a wide array of props, including bits of junk that Peter Walpole and I gathered from an aircraft graveyard in Arizona, and pieces of space junk from the original *Star Wars* films, which George dubbed 'greeblies.' In fact, we even used Luke's landspeeder in one scene; we just painted it a different color and put it up on bricks as though it was broken down!"

To create the slave quarters where Anakin and his mother live, Bocquet sought out an existing Tunisian site. During location scouting, he came across a range of two- and three-story barrel-bolted grain stores called Ksars, which are common throughout the towns and villages of North Africa. "When we saw those, we suggested to George that maybe they could serve as the basis for the slave quarters. We built a bit more onto them, adding steps, techie doors with futuristic controls, and so on. We started out with a real environment, but built it up into something that hopefully looks very otherworldly.

"For the interior of Anakin's hovel, we took our references from the Skywalker homestead in the first *Star Wars* film, using the same sorts of 1960s-style soft forms and instruments," Bocquet concludes. "We augmented things a bit with different types of set dressing, but I think George felt that in Tatooine, nothing much would change over the course of several decades! It will probably be the same in the next two films as well, but we'll just have to see." ■



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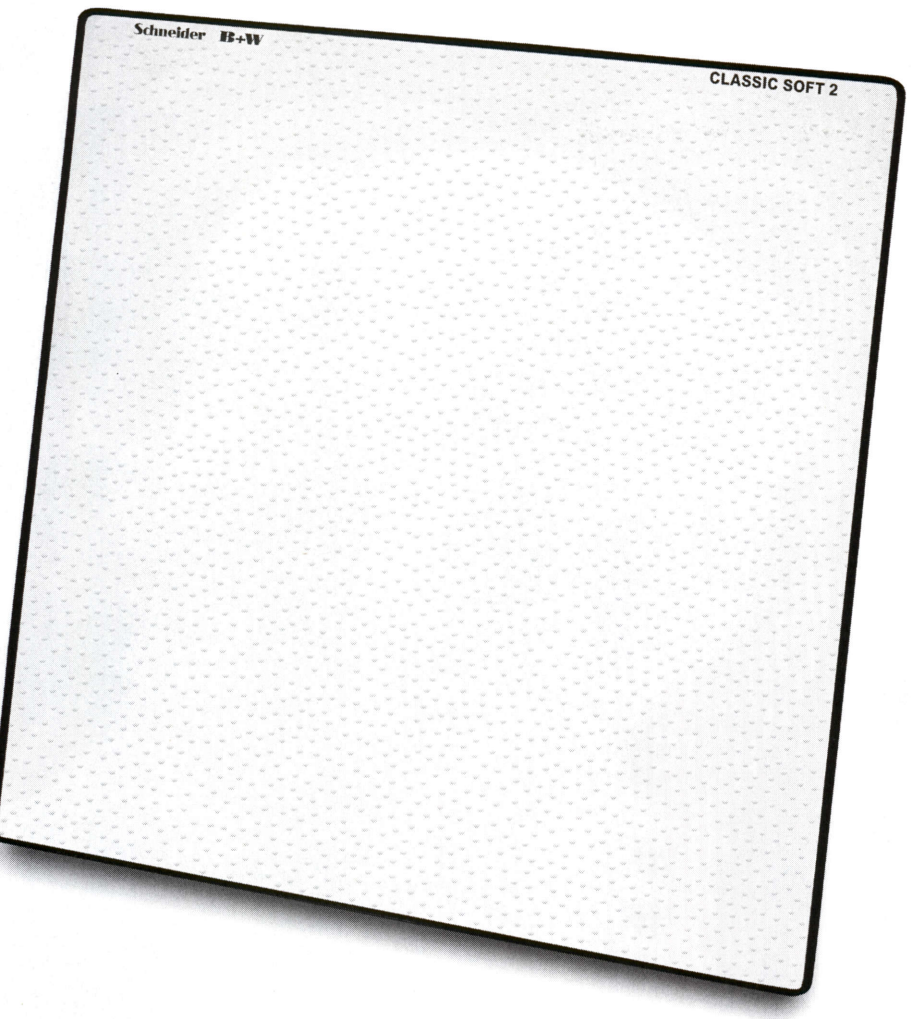

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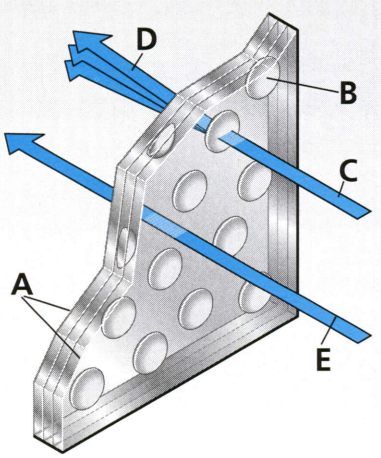

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Phantom Camerawork

A longtime Lucas collaborator, director of photography David Tattersall, BSC, discusses his contributions to *Episode I*.

by David E. Williams

Unit photography by Keith Hamshere, Giles Keyte and Jonathan Fisher

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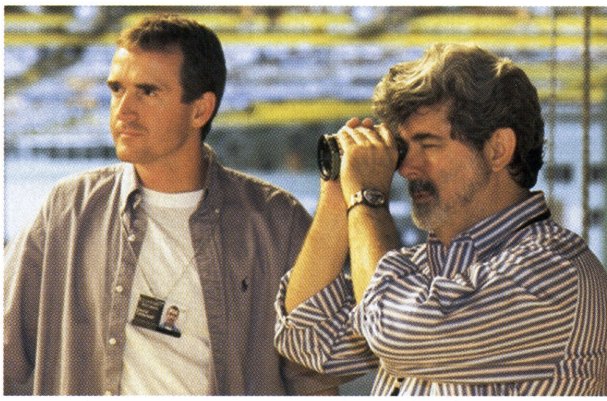


Director of photography David Tattersall, BSC saw the finished print of *The Phantom Menace* under what could be considered ideal conditions: with an avid crowd of youthful *Star Wars* aficionados at a matinee show in Los Angeles. "I was on location shooting another picture while the final timing was being done on *Episode I*," Tattersall explains, speaking from New Zealand, the site of his latest production, a mountaineering thriller entitled *The Vertical Limit*. "I also missed the premiere, but I was in L.A. for one day before going out on a location scout in Arizona. The picture had just opened, so I was able to see it with the fans, who really enjoyed it."

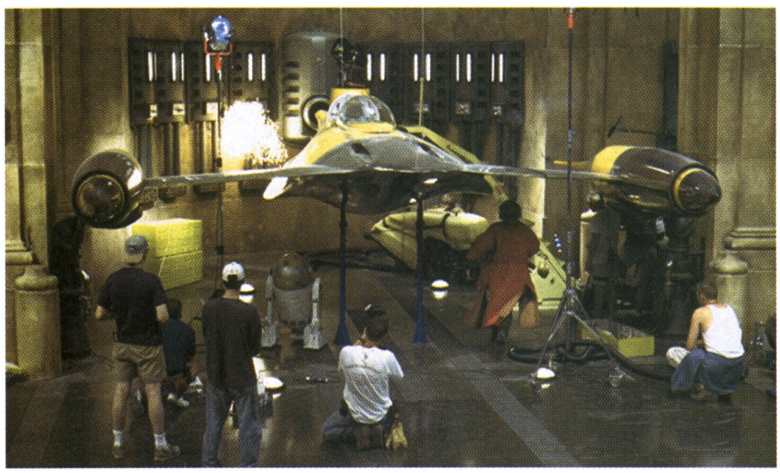
By that point, the *Star Wars* galaxy certainly seemed a long time ago, and far, far away to Tattersall, who has photographed three features (*Soldier*, *Whatever Happened to Harold Smith?* and *The Green Mile*) since filming *Episode I* for director George Lucas. "One has to realize that *The Phantom Menace* was shot in just 65 days, while the postproduction work took another 20 months or so," Tattersall explains. "Many sequences were created entirely at Industrial Light & Magic, so it's a film that was defined not only in preproduction and on the set, but in post. In a way, I had one of the shortest tenures on the project!"

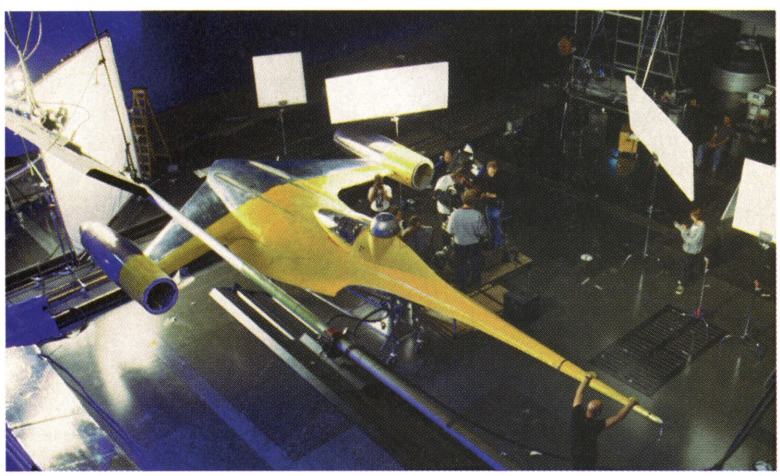
The accomplished cinematographer, whose other credits include *The Wind in the Willows*, *Moll Flanders* and *Con Air* (see *AC* June '97), first collaborated with Lucas and *Episode I* producer Rick McCallum on *The Young Indiana Jones Chronicles* (1992-'93), which not only featured a weekly dose of classic derring-do, but groundbreaking digital visual effects (see *AC* Oct. '92). The show, which earned Tattersall both Emmy and ASC Award nominations, was a fruitful testing ground for CG effects work. On that project, logging hours in a Quantel Harry suite proved far more frugal than working practically. "The main lesson we learned on the series was that we had a lot more control over our locations, in that with a little digital help, we could erase or replace what we had," Tattersall recounts. "For instance, a lot of the episodes were shot in Prague, in [what's now the Czech Republic]. We could use it as a double for most European cities, like Paris or Vienna, simply by having the skyline changed. Another important thing was learning how to replicate crowds — to make 25 soldiers look like an army, for example. That type of thing seems very straightforward now, but it was a great innovation at the time, and cost-effective."

Other budget-pleasing innovations included shooting the show

Opposite: Jedi knights Qui-Gon Jinn (Liam Neeson) and Obi-Wan Kenobi (Ewan McGregor) face off against their enemies in the Theed Palace hangar. Opposite, bottom: Only half of the hangar was actually built, with the rest added in post by ILM. A huge bluescreen on the right-hand side extended the 275' length of the set, and Mylar was placed over the stage floor to reflect the hanging backlit material and create a seamless, floor-to-ceiling screen. Tattersall (above, with George Lucas) lit the huge bluescreens with blue-spiked fluorescent units.

Phantom Camerawork





Lighting the chrome-detailed Naboo starfighters proved tricky for Tattersall, as the ships' mirror-like surfaces tended to pick up reflections of his bluescreens. Lighting the ship with controlled reflections — as one would with a sports car — helped alleviate the problem, and visual effects supervisor John Knoll offered further assistance with software that could fix problematic areas.

on 16mm and utilizing 35mm only for plate photography, as well as using McCallum's Canon XL-1 Hi-8 camera to shoot some effects elements. At the time, Tattersall remarked, "I've got a theory that sophisticated postproduction techniques on digital tape will be used more and more in the future, to give scale and drama to otherwise small tableau scenes." And how.

The cinematographer continued to prove this concept with Lucas and McCallum while filming *Radioland Murders* (see *AC* March '95), a comedic period piece that served as a final test for the "digital backlot" filmmaking approach established on *Young Indy*. "That film also offered ILM one of the first opportunities to work without having to lock off the camera or depend on motion control," Tattersall submits. "Prior to that, bluescreen work was always done in a careful, very 'monitored' sort of way, which would allow the audience to spot a bluescreen shot coming from a mile away. The camera would suddenly stop moving, the visual effect would happen, and then the film would begin again. But on *Radioland*, the goal was to shoot unrestricted, so we shot things as if the bluescreen didn't exist. All of the camera moves — pans, tilts and dollies — were matched later in post."

Radioland featured 100 visual effects shots. Hi-8 and ¾" video was again employed for some of the element photography, while matte paintings, miniatures, and unobtrusive CG "fixes" allowed production-oriented creative decisions to continue well into the picture's post phase, extending the physical scope of the film well beyond its modest budget. Lucas was convinced that this filmmaking methodology — a combination of extensive visual effects work, virtual locations and a much more mobile camera — would allow him to revisit the *Star Wars* universe with exciting (yet cost-effective) new storytelling options.

The lessons learned on these projects and others were directly applied to the conception of *The Phantom Menace*. During production, Tattersall was called upon to refine the shooting methods he'd helped establish. Because so much of the picture would be completed in post, Tattersall found himself working on a largely "virtual" production. "The extensive use of bluescreen on *Episode I* is what made shooting the picture so very different from any other I've done," the cameraman attests. "The sheer amount of bluescreen material was amazing."

While planning his lighting style for *Phantom*, Tattersall "checked out a number of science-fiction and fantasy films, and then went through a process of elimination regarding things I liked and didn't like. It soon became obvious that the only relevant source of information would be the original *Star Wars* trilogy. To fly off on a tangent with another style would have really been wrong. George and I always came back to the idea that the feeling of *Phantom* — especially in the scenes set on Tatooine — should be very much the same as what we've seen before.

"It's very difficult to put my finger on exactly what that the *Star Wars* style is, but design-wise, there are elements that are organic and technical, high-tech and low-tech, classical and futuristic. There are touches of everything, but as in real life, they seem quite naturalistic when they're blended together.

"On sets where the bluescreens were such a large portion of the frame, light balancing became more difficult. The temptation would be to pitch for a brighter exposure on live-action foreground elements to

contrast them with the bluescreen. However, if the background plate was to consist mainly of bright tones, a darker exposure would be more effective. But naturalism was always the aim, and we sought to keep the light as soft as possible."

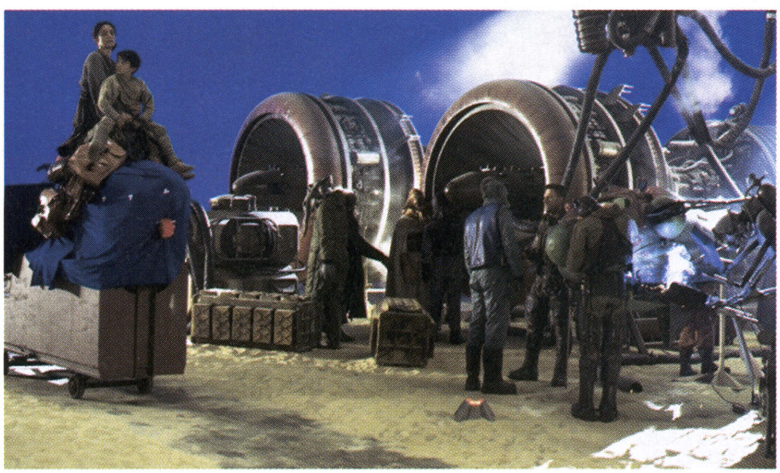
Another major — but subtle — part of the *Star Wars* visual style comes from the use of classical compositions and camera movement. "It's a very solid, restrained style that's definitely not flashy," Tattersall agrees. "George doesn't favor cinematography that draws attention to itself, which leads to a more formal style. I'd just finished *Con Air* before signing on for *Phantom*, and I had to 'unlearn' a lot of things I'd been doing — radical camera moves using hotheads, long lenses and such."

It was determined during prep that Arriflex cameras could offer both Tattersall and ILM what they required photographically. "We had a great relationship with Arriflex and their U.K. rental house, Arri Media, on *Young Indy*, so it was a logical step to work with them on *Episode I*," the cinematographer states. (See sidebar on page 74.) "We used Arri's 435ES and 535B cameras. The 435 is great because it's a high-speed unit and can run up to 150 fps — which makes it the highest-speed camera of its kind — and it has plate-quality image stability, which is quite extraordinary. The entire film was really a big exercise in plate photography, since so much of our first-unit production footage was going to be digitized and used for effects shots.

"Arri also did a tremendous amount of work in developing their Data Capture System [DCS], which supplied ILM with all the information they needed in order to know exactly what the camera was doing and where it was physically positioned during each shot. That made it easier for them to do their digital work. [See sidebar on page 62.]

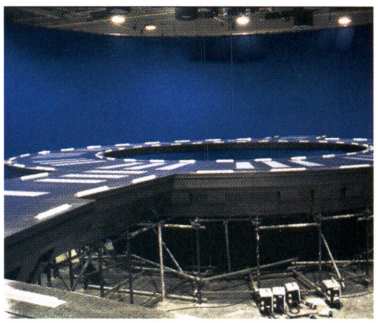
"We still had a surveying team working with us during the shoot, collecting spatial and topographical information, but the DCS unit recorded everything regarding the camera itself: focus, aperture, zoom controls, the geared head, the dolly, et cetera, and fed it into a laptop. Together with the information collected by the survey team, ILM had a very good idea of what we were doing on each shot; they could replay any camera move in the virtual environment, which avoided the usual laborious match-moving process. The DCS required the camera assistant to do about 30 seconds of extra work on each take, but overall it had very little impact on our work."

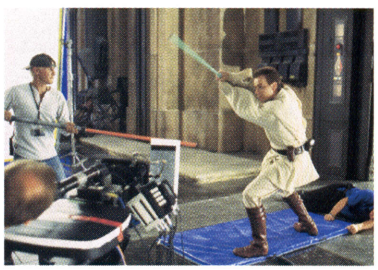
Another novel tool used on *Phantom* was the Hawk anamorphic lens systems supplied by Arri Media (see sidebar on page 66). Tattersall remarks, "Those lenses are new to Arri's kit, and I'd never used them before, but they have a great range of primes, from 30mm to 250mm, and two zooms. In the past, I've used Cooke or Zeiss lenses with Arri cameras, but now I'll have another choice with the Hawks." The cinematographer adds that chart tests were done with the Hawks, and full optical specifications were forwarded on to ILM. He explains, "Because of their complex design, each [model of] anamorphic lens has its own unique characteristics, and any individual set has variations. All have their different strengths and weaknesses. For instance, some anamorphics tend to have aberrations at the top or side edges, or sometimes even a bit of general vignetting at the four corners. ILM had to determine the characteristics of the Hawks because they had to re-create those artifacts in their virtual photography so the entire film would feel cohesive."



Above: Riding atop a pair of "eopies," Anakin Skywalker (Jake Lloyd), Queen Amidala (Natalie Portman), Anakin's mother, Shmi (Pernilla August) and a young friend are confronted by Watto at the Anchorhead Arena hangar. The smoke, steam and atmospheric effects used while shooting on the partial set (left) required the scene's wide shots to be covered in VistaVision.

Phantom Camerawork





Above: Qui-Gon Jinn and the evil Darth Maul (Ray Park) duel in the power station beneath the Queen's Palace. The environment was largely virtual, with only pieces of sets built and later extended (right, top). Tattersall used VistaVision (right, center) whenever the frame comprised more than 50 percent bluescreen. Right, bottom: Filming Darth Maul as he plummets 80' to his doom.

The Hawk primes are rated from T2.2 to T3, but Tattersall maintained a T4.5 while working on stage. "The rule of thumb is that anamorphics work best at about two stops over their minimum," he says, adding that the coatings on the Hawks prevented lens flares even in harsh backlight.

Tattersall's use of filtration was specifically inspired by the fine camerawork that Gilbert Taylor, BSC contributed to the first *Star Wars* picture. "The filter used throughout much of the original film — especially in the desert, which George quite liked — was a nylon-stocking net stretched in front of the lens. We experimented with a lot of nets, low-contrast filters, and diffusion. In the end, we decided to use a ¼ Tiffen ProMist for everything, including close-ups and wide shots. George really wanted to take the edge off things, which is of course more flattering on the actors. However, there were a situations in which ILM's advice was to shoot clean, and that they'd add the filtration effect later.

"That was the case with the wide shots inside the Mos Espa hanger where Anakin prepares his podracer. It was a very complicated environment for ILM because there were a lot of steam, smoke and atmospheric effects in there, in addition to the huge bluescreen behind these ships. Keying that blue was already going to be difficult for them, so we took the filter off."

The complexity of the foreground and background elements in this particular scene (and others) also required it to be covered in VistaVision, although 4-perf was the standard format throughout the production. Generally, the 8-perf cameras were utilized for wide, panoramic shots, and those "in which the bluescreen element was more than 50 percent of the frame," Tattersall details. "It's generally more convenient to use the 35mm cameras, so virtually all of the dialogue scenes and close-ups were done in 4-perf, but the masters and extremely complicated shots were done in VistaVision."

Tattersall's main film stock on *Episode I* was Kodak's lower-con Vision 320T 5277. "We also used [EXR] 5245 in Tunisia, since there was certainly plenty of light!" Tattersall says. "Going back a bit, the reason for choosing a T4.5 as our general stop came from discussions about the bluescreen work, knowing that we wanted crisp edges on the background objects while keeping focus on the foreground action. Carrying that depth was crucial, and required the deeper stop. If there were no bluescreens, we could work comfortably at a T2.8 or less.

"Now, to work with a 100 ASA stock like [EXR] 5248 at a T4.5 on our large sets, with a softlight approach, would have required such an enormous amount of light that the heat would have been unbearable. While testing faster stocks, I just preferred the 320T, and although Kodak describes it as low-contrast, I don't find it to be such."

Tattersall's production team was largely composed of fellow *Young Indy* veterans, although "we had plenty of people calling who would have worked on a *Star Wars* film for free," the cameraman says with a laugh. "My gaffer, Eddie Knight, and I have done a few films together now, and he was my first choice. He then chose his own electrics crew. The camera crew included Trevor Coop, the operator, Graham Hall and Ben Butler, our focus pullers, and our loaders, Jason

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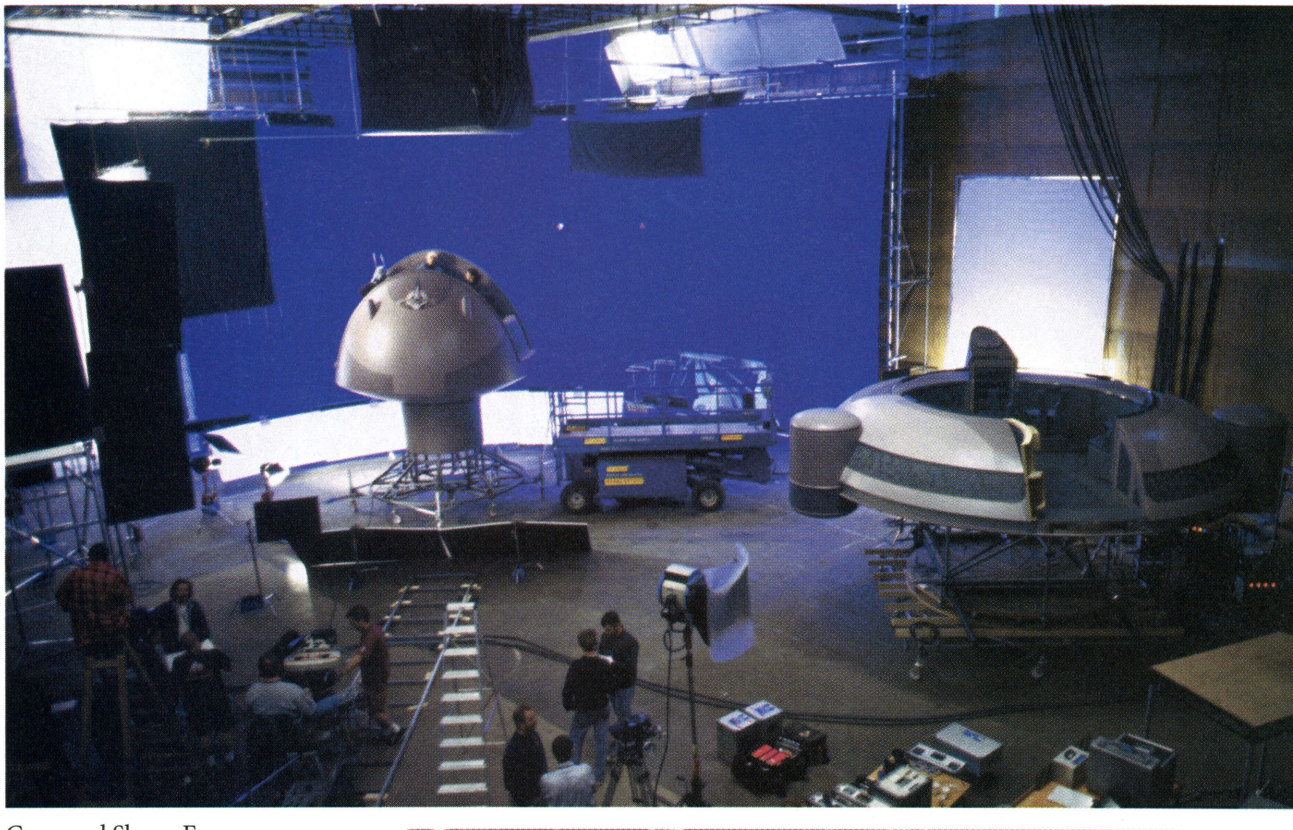
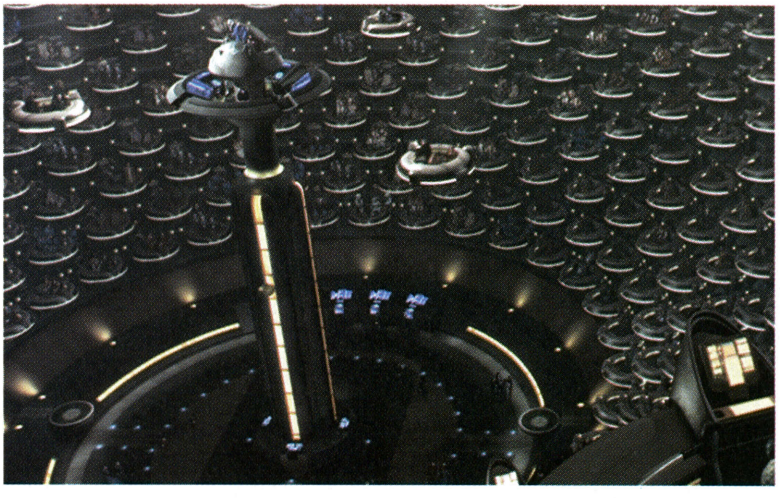


The Senate Chamber sequence was one of the first filmed during the initial phase of production at Leavesden Studios. The arena's complex architecture was almost entirely computer-generated, with Tattersall's crew primarily covering the two full-scale set elements containing the main performers.

Coop and Shaun Evans.

Principal production began in June of 1997 at Leavesden Studios, the 286-acre filmmaking facility located outside London. Tattersall notes, "Leavesden wasn't built as a studio — it was an old Rolls Royce aviation factory before it was converted for film work. The advantage for Rick and George was that they could lease the entire facility; they didn't have to share anything with other productions, which is the usual situation in a studio setting. Because of that, many sets could be built at once, and left standing indefinitely. Our production designer, Gavin Bouquet, had about 15 quite large spaces to work with, which gave us the room to have some 25 fully constructed sets to shoot on."

This long-term arrangement at Leavesden worked well with the production's general shooting schedule. "We had three distinct phases on the production," Tattersall explains. "The first was to work our way through our initial 25 sets at the



studio [including the Galactic Senate chamber, the Mos Espa arena, Watto's junk shop, and Anakin's home on Tatooine]. In the second phase, the company moved on to Italy and then Tunisia for location work [depicting the Queen's Palace on Naboo, and scenic desert exteriors on Tatooine, respectively]. Meanwhile, all of the wrapped sets at Leavesden would be replaced with new ones — we'd then return to shoot phase three, using the next 25 sets [including the Jedi Council Chamber, the starfighter hanger in Theed, and the Palace's generator complex].

"The advantage to this plan was that we had time to pre-rig and pre-light before we began shooting phases one and three, which allowed us to just go from one set to the next."

One of the first scenes to be shot at Leavesden depicts the drama unfolding in the vast Galactic Senate

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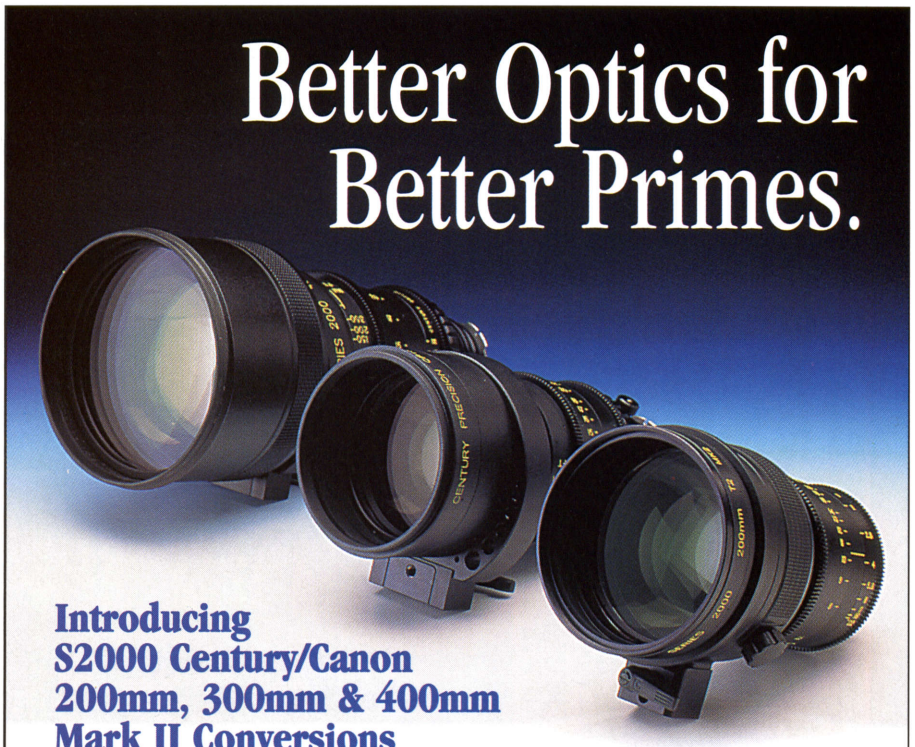

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chamber. The arena features a central lectern, as well as thousands of intergalactic representatives seated in individual platforms docked along the chamber's walls. During presentations, these platforms can detach and hover toward the lectern, allowing the speakers aboard them to address the entire Senate.

Only a few key elements of the chamber were constructed full-scale (including the lectern and one delegate platform), with the remainder created in post at ILM. While filming the Senate sets, Tattersall made extensive use of dolly and crane work to create the impression that the platform was indeed moving, while the Arri DCS unit recorded his moves so ILM could easily retrace his steps.

The bluescreen surrounding these setpieces was quite enormous and a major lighting chore — but just one in a long series of such challenges. Explaining how he tackled this extensive bluescreen-illumination job, Tattersall relates, "AFM Lighting provided our lighting gear for the show. It's a London-based company run by really good people, and they have great gear. One of the terrific things they supplied us with were these blue-spiked fluorescent units called Jack Flos, and we used 160 of them for our bluescreen work. AFM designed them with four 5', 120-watt tubes, using a pure-blue tube, which made them very efficient for us and perfect for what ILM wanted. The next most powerful such tube on the market is about 65 watts, so they're just over twice as powerful, which allowed us to use fewer units and effectively fewer cables and less rigging time. We could also place them a bit further away from the bluescreen than normal, which made the coverage more even.

"On each bluescreen, we used two lighting pods made up of these Jack Flos: one hung from up above and one on the floor, each set 15'

Continued on page 64

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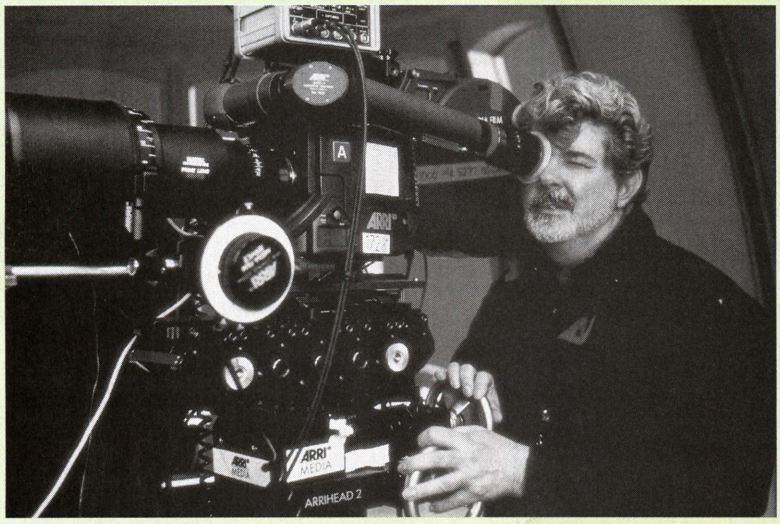
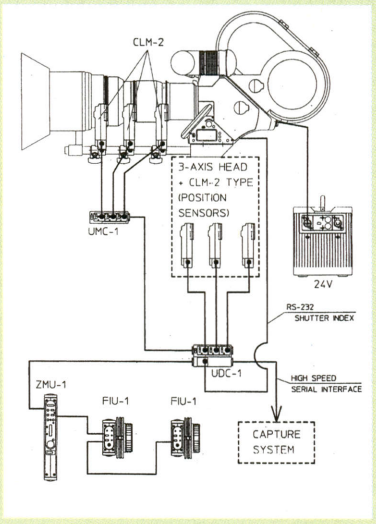
by Jay Holben



George Lucas gets an eyeful of Arri's Data Capture System, diagrammed at far right.



A few technological hurdles needed to be overcome before principal photography could commence on *The Phantom Menace*. One was the classic post problem of matching live-action photography with CG effects. This is normally done under the supervision of an effects unit, most often employing motion-control cameras. However, because the film would feature several all-CG characters, virtual sets and other effects, nearly every shot in the film was an effects shot. Seeking to avoid the sloth-like production pace usually dictated by motion-control systems, Lucasfilm turned to Arri Media, the London-based Arri rental house supplying cameras for *Episode I*, to devise a solution.

Industrial Light & Magic was looking for way to capture pertinent camera information (including focus, iris, zoom, fps and time code, as well as pan, tilt, roll and dolly positions) and feed it into a database each time a frame was exposed. Also, since this system would set the overall production pace, it had to rapidly accomplish its task.

Lucasfilm had already decided to employ Arriflex 535B and 435ES cameras on the production. Since all new Arri cameras (and most of their accessories) are controlled by digital electronics, this provided a great head start toward achieving the necessary communication between the components of the camera system. In 1990, when Arri unveiled the 535, then camera assistant Marc Shipman-Mueller came up with the notion of linking the camera to his laptop computer via the provided serial port. Arri supported this idea, which resulted in the Laptop Camera Controller, and later inspired the Data Capture System (DCS) used on *The Phantom Menace*.

"The way to think about the DCS is that it's a funnel for information," explains Arri Media technical manager John Duclos. "We're sampling information from many different sources and then sending that down a single cable."

The existing digital systems within the Arri 535B and 435ES cameras already sensed fps, shutter-angle, time-code and footage information, and could output this data via the camera's serial port. Also, Arri's Controlled Lens Motors already have encoders in them to note their positions. All that remained was to gather information from the head and dolly positions.

Arri engineers used a passive magnetic system to gather information from the tripod head. A magnet reader was attached to the stationary portion of the head, and a second magnet was attached to the moving portion. At any given moment, the reader could determine how many degrees in rotation the moving magnet was from the reader, and report that information. This was done for pan, tilt and roll positions. A traditional geared encoder was used to gather the dolly's arm-height information. Finally, another geared encoder wheel was mounted on the base of the dolly to ride against the inside of the track. A strip of Velcro was run down the inside length of the dolly track, and the opposite side of the Velcro was wrapped around the encoder so that as the dolly moved, the encoder would positively roll along the track and report back the relative position.

All of these separate compo-

Photo and diagram courtesy of Arri Media.

nents were fed into a central Universal Data Capture box. "Inside the UDC," explains Shipman-Mueller, now a technical representative for Arri, "the separate pieces of information are combined and correlated to the camera shutter pulse. For each frame exposed by the camera, the UDC sends out a message which includes the following information: frame number, time-code number, userbits number, feet-per-second, shutter angle, tripod pan, tripod tilt, tripod roll, dolly track, dolly height, and dolly spare. ILM then wrote software that exported the information from the UDC in a format that their computers could understand."

The DCS was first tested at Leavesden Studios in June of 1997, and the *Phantom Menace* crew quickly acclimated to the protocol changes involved in working with it. First, the system does not record absolute information, but rather relative information based on its position within the set. The crew would have to "zero out" the DCS for each setup: a quick task of putting the elements — focus, iris, dolly and head positions — at their extremes, physically measuring that position in reference to predetermined elements of the set, and logging that data for future use. That extreme position is then recorded into the DCS as a zero point; from there, any movement of any encoded component is reported back to the DCS in relation to that set zero point.

At the beginning of each roll, a bloop light had to be held in front of the camera to visually correlate the captured frame numbers with the images on film. With the information from the DCS, ILM could then re-create the complete camera move in a computer. Since the DCS was used on almost every take, effects could be later added to any setup, not just those previously declared to be visual effects shots. ■

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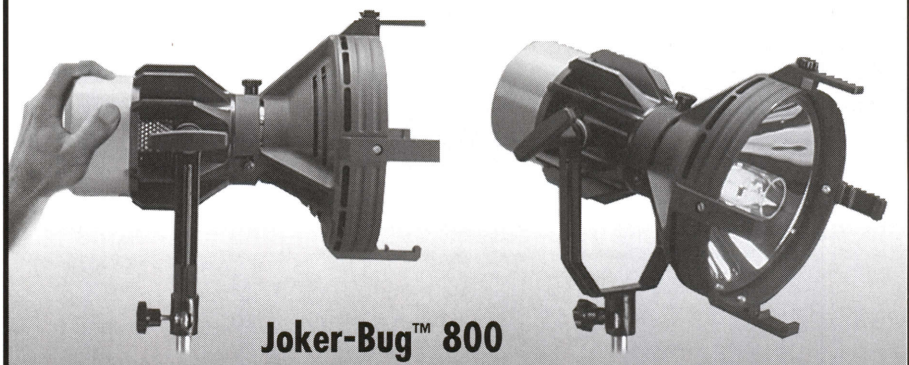
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from the screen. That would give us an even T4.5, so wherever we had a bluescreen, we just made sure that the construction crew gave us space for our lighting pods. Since the lighting on the bluescreens dictated our shooting stop — as they had to match our key light — it was important to keep that routine going.

"The main thing was to give ILM a dense negative to work with. The principal photography was really just a foundation upon which the rest of the film could be built."

Asked to describe Lucas's preferred shooting style, Tattersall reports that two cameras were generally used to cover every setup — one wide and the other tighter, but at the same angle. "The first camera would cover for the storyboard, while the second would get something else — it was fairly conventional," the cameraman reports. "The first unit would start with George and then the second unit — with cameraman Giles Nutgens — would follow up behind to pick up their material. Giles shot several episode of *Young Indy*, so again he was somebody familiar with our procedures.

"George was very hands-on during shooting, and every sequence was planned and detailed with storyboards or animatics that we'd refer to over the day. Also, because we had so many standing sets, we were able to spend a good amount of time walking through them and working out how we'd be shooting things."

Considering the amount of preparation that went into making *The Phantom Menace*, it seems logical that very little footage would end up on the cutting room floor. "You'd be surprised," Tattersall admits. "The editing process is one of George's passions, so we provided him with plenty of raw material. I don't think it's any secret that we shot 1.25 million feet of film!"

The large amount of footage was accumulated in part because Lucas prefers to do traditional master-shot coverage, which allows him the most flexibility in the editing room. "The first shot of the day was always a master," Tattersall details. "After that, it was a matter of moving in to get two-shots, over-the-shoulders, and close-ups. We then switched to the reverse angle and repeated the process. It's really a classical way of getting coverage, and so many other directors tie themselves in knots, from an editing standpoint, by not doing exactly that.

"The great thing about doing a wide master first is that nobody on the set is in any doubt about what's going on in the scene, which is important when there are so many effects. If a director begins with the close-ups, or something in the middle of the scene, confusion can very easily occur."

Because editing was being done by Paul Martin Smith and Lucas concurrent with shooting, and because many of the sets stood long after scenes utilizing them were wrapped, it was also easy for the first unit to return to any given scene for additional footage if necessary.

Another methodology carried over to *Phantom* from the *Young Indy* and *Radioland* experiments was the use of video dailies. Tattersall's footage was processed at Rank (Deluxe) Laboratories in London, sent to Midnight Transfer for telecine, and then shipped on to ILM for scanning. "I can't say it's my preferred way of working," Tattersall says of video dailies, "but it can be more convenient, especially when you have miles of dailies to sit through. We did have some projected dailies, however. If anybody had a particular request to have something screened, individual shots would be printed up and projected large, which sometimes answered some very important questions regarding costuming, makeup, and focus. Sometimes when we were coming onto a new set, I'd request film dailies just so I knew I had the proper light-

ing approach. Ian Robertson was our client liaison at Deluxe; I'd worked with him on many projects before, so that was also a help."

The location work done for *Phantom Menace* was minimal, yet pivotal in adding a degree of realism to the drama. "Rick and Gavin had done an extensive location scout, so the locations I saw were pretty much the final choices," Tattersall remarks. "It seems that they always intended to go back to Tunisia — where part of the original *Star Wars* was shot — in order to recapture that environment for the planet Tatooine.

"It was especially difficult to find the perfect location to depict Queen Amidala's Royal Palace. All of the large palaces in Europe were scouted, but Reggia Palace in Caserta, Italy, just north of Naples, was selected because it featured the types of spaces we were after. George was looking for something on a massive scale, and which featured classical architecture that could then be digitally enhanced and extended to seem even bigger."

Unfortunately, Reggia Palace is also a popular tourist attraction, and could only be secured for a handful of shooting days — from the late afternoon and long into the night. "Shooting in Reggia Palace was difficult for other reasons as well, primarily because we were shooting in anamorphic," Tattersall adds. "The architecture there is almost entirely vertical, so composing shots that really took in the structures was sometimes hard, and we were limited in what we could do in there because it was a historic place."

In one key scene there, Queen Amidala and her assault team are pinned down by a platoon of Battle Droids within a vast corridor of polished stone. To escape, they blast though a large window and use grappling-type hooks to climb to the next level of the castle-like structure. "Unfortunately, we couldn't get

Continued on page 68

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PHANTOM OPTICS

German technology and Russian design result in the Hawk anamorphic lenses.

by Jay Holben

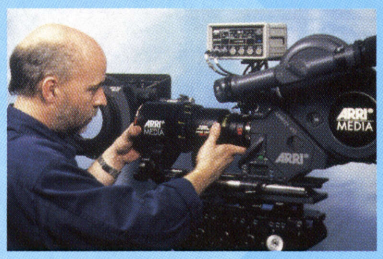
Like the original *Star Wars* films, *The Phantom Menace* was intended to be an anamorphic film from the get-go. However, when the decision was made to utilize Arriflex cameras, a problem arose: securing enough anamorphic lenses to supply full sets for three cameras. "Arri Media has their [Powerscope] lenses, but there are only a few sets of them — no enough for all of the cameras Lucasfilm wanted," says Renos Louka, director and general manager of Arri Great Britain Ltd., a retail sales outlet of Arri equipment in the U.K.

However, some time before *Phantom* arose, Arri G.B. had discovered a new German optics company called Vantage Films, which had been founded by Wolfgang Baumler and Peter Martin, two German camera assistants who were driven to create their own anamorphic lenses. Through a joint venture with Arri G.B. and Arri Media, the Arri family helped fund Vantage's efforts, which resulted in the Hawk series of anamorphic lenses.

Baumler and Martin formed Vantage Films in search of the optical Holy Grail: a set of anamorphic lenses that could compete in quality with spherical lenses. "In 1990-91, when Russia opened up their borders, a lot of people were looking for work," recalls Baumler. "The Russians had a lot of experience in designing anamorphic lenses, because in Socialist times they were given a lot of money to develop things. With the borders open, we were able to contact some amazing optical designers and talk to them about making lenses for us.

"Because we worked with Russian designers, many people think that [the Hawk lenses] are remanufactured Russian lenses. They are not. These are brand-new German lenses based on Russian calculations. Many of the parts in the first few sets were made by a Japanese company, but now everything is done at Rodenstock in Germany."

Over the past four years, Baumler and Martin have manufactured 12 sets of Hawk anamorphic primes. Their range includes the following lengths: 25mm, 30mm, 35mm, 40mm, 50mm, 60mm and



75mm (all T2.2); 100mm, 135mm, 180mm and 250mm (all T3); and a 350mm (achieved with a custom 1.4x extender calibrated exclusively for the 250mm lens). Their zooms include a 46-360mm, a 55-165mm, and a new 300-900mm (all T4).

"Aesthetically, the Hawks are very pleasing, and they handle flares very well," opines Arri Media technical manager John Duclos. "They flare white, which is very nice."

"We have no problems with backlights or practicals in a shot," contends Baumler. "We've eliminated that problem with the Hawks. We use a good four-layer multi-coating on all of our elements. We've also placed our focusing group in the front of the lens, and the anamorphic element is in the middle [as opposed to the front] — it's relatively small, which helps eliminate problems with lens flares.

"Another difference in the Hawk lenses, as compared to other anamorphic lenses, is that we don't start with great spherical lenses and make anamorphics out of them. We designed all of our lenses together from the outset to be good anamorphics. Our spherical elements are calculated exclusively for each specific anamorphic lens, and wouldn't be any good on their own as spherical lenses. The spherical elements are all calculated and fixed for infinity focus; we then put in a focusing group before our anamorphic element, which is calculated without compromises to do its one specific job.

"Most anamorphic lenses have a bit of breathing in them, but we found some Russian lenses from the 1960s that were perfect — which is what prompted us to turn to those designers," Baumler continues. "With the Hawks, we have totally eliminated the breathing problem, and the focus performs like a spherical lens would.

"Also, since all of the Hawks are made with the same optical concept from the same designer, they all match perfectly. That was one of our goals from the beginning. All of the lenses are the same, so the last customer to get the lenses will have the same quality that the first one did."

In a letter dated April 8, 1997, Simon J. Broad, the business manager of Arri Media, wrote to Peter Martin in regard to director of photography David Tattersall, BSC's tests of the Hawk lenses for *The Phantom Menace*. Broad wrote that Tattersall "was very pleased with their sharpness at the stop he hopes to work at, which is between T4 and T5.6. Wide open, he felt that they were not as crisp, but added that no anamorphic lens was. He was impressed by the color-match between lenses, and [also] by their coatings. He conducted a flare test and was pleased with the result." ■

Arri Media technical manager John Duclos inspects one of Vantage Films' Hawk anamorphic lenses.

Photo courtesy of Arri Media.

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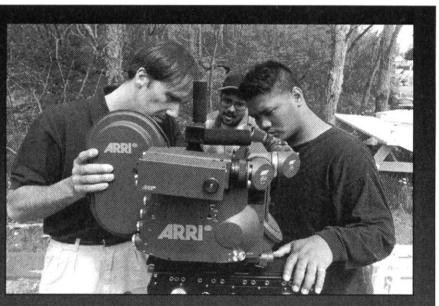

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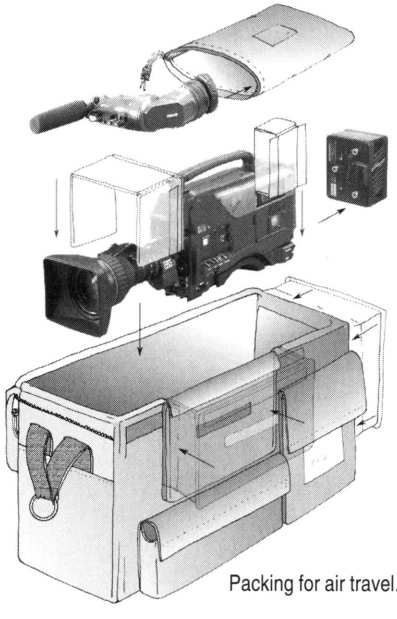

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permission to use squibs — explosive charges — while shooting in Caserta," Tattersall says. "But Gavin did a brilliant job of reconstructing that corridor from Reggia Palace back at Leavesden after we returned to England — for just one day of shooting. That let us blow chunks out of columns and shatter the windows, but it had to match what we'd shot at Caserta."

Due to Tattersall's overall soft-light approach, lighting such enormous spaces required immense wattage. "Well, we did have a lot of power on hand," Tattersall jokes. "But we usually just flew a series of 20' by 12' silk panels outside the set windows, and aimed Maxi-Brutes through them to create the softest sources possible."

In August, the production moved on to Tunisia. "Shooting there was quite an anxious time, because I don't think anybody quite predicted how hot it was going to be," Tattersall begins. "The temperatures were quite scary, photographically speaking, especially on the days when they got over 130°F. My main concern was whether the film would actually melt in the camera. We'd tested the cameras during prep in Arri Media's climate-controlled box, letting them run for a day, but only at 120°F.

"On the set, we had a routine in which the film was kept in an air-conditioned storage truck and then very gradually brought up to temperature by transferring the cans into different vehicles kept at different temperatures. We hoped that would prevent condensation, warping, or whatever. Then, after exposure, the footage was quickly brought back to a reasonable temperature."

A seemingly simple sequence on set on Tatooine became one of the few occasions when the first unit used more than two cameras. "It was a dawn sequence, in which Anakin is working on his podracer," Tattersall remembers. "We actually shot it at sunset, so we could rehearse the

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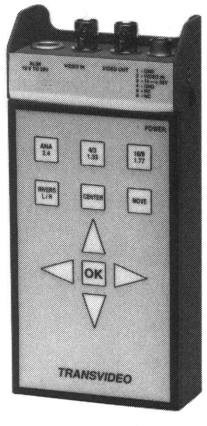

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NEW PATHS FOR LIGHT

Texas Instruments and Hughes-JVC shed new light on digital film exhibition.

by Jay Holben

On July 18, 1999, audiences in four U.S. theaters witnessed a revolution in feature film exhibition — watching a movie without film. For four weeks, digital projections of *The Phantom Menace* were presented at theaters on each coast: the AMC Burbank Media Center 14 in California and the Loews Meadows 6 in Seacucus, New Jersey. Both houses utilized Texas Instruments' Emmy-winning Digital Light Processor (DLP) in a prototype projector. Meanwhile, at the Pacific Winnetka Theater in Chatsworth, California and the Lowe's Cineplex Odeon in Paramus, New Jersey, the Hughes-JVC Corporation exhibited its own Image Light Amplifier (ILA) 12K Projectors.

These presentations — held by Lucasfilm, THX, CineComm, Texas Instruments (TI) and Hughes-JVC — mark the potential for a drastic change from the distribution paradigm as it currently exists. "Despite all the hype you hear about digital projection," says *Phantom* producer Rick McCallum, "this technology represents the first real step forward for filmmakers who care about the way audiences see their work. For over 20 years, Lucasfilm and THX have dreamed of the day when viewers could see a film without any loss of image quality throughout its entire theatrical run."

To create the digital *Phantom* that was used for these presentations, an interpositive was struck from its master negative and transferred to D-5 HD tape at Modern VideoFilm in Burbank, California, under the supervision of THX's principal video engineer, Dave Schnuelle. Two transfers were done, each optimized for the respective projector systems. Colorist Skip Kimball corrected the transfer for the TI projector, and Greg Garvin colored the Hughes-JVC transfer. Both were done on a Spirit DataCine in 8-bit 4:2:2 at 1920 x 1035 resolution. That data was then compressed by the Panasonic D-5 recorder at 4:1 to 1280 x 1024. The D-5 tapes were brought to International Video Conversions in Glendale, California, where a screening room with a 24' screen was set up with three projectors: a standard 35mm rig, TI's DLP, and the Hughes-JVC ILA-12K. The movie was then "compared and corrected to get [both telecine transfers and the film print] looking as close as possible to each other," submits Robert Lemer, who represents CineComm Digital Cinema, a company positioning itself to be a satellite delivery service from distributors to exhibitors with digital projectors.

The final HD data was transferred to Pluto RAID disk arrays (consisting of 20 18-gig drives) for presentation at the four theaters.

CineComm represents a key component in the proposed digital distribution paradigm. "We're in a position to replace the labs and [the shipping company] in the delivery of films to exhibitors," maintains Russell Wintner, CineComm's co-founder and chief technical officer. "The film will be given to us by the studio, after which we'll compress and encrypt it, uplink it to the satellite and address it down to theaters. There, the information will be stored on our Theater Management System, a RAID array totaling about 350-400 gigs that will handle 10 to 12 screens.

"The compression algorithm — at 50:1 — is a proprietary development by QualComm. It uses an adaptive block size, whereas current MPEG and JPEG algorithms have a fixed block size. That allows our compression to be much more efficient because it compresses an entire frame without regard to the frame before or the one after, as opposed to MPEG, which compresses information based on the differences between the frames. The inherent difficulties of current compression technologies — such as motion artifacts — are eliminated."

The Hughes-JVC ILA-12K projector is based on liquid crystal Light Valve (LV) technology designed by Dr. William Bleha, Hughes-JVC's vice president of engineering. The LV is a spatial light modulator that accepts a low-intensity light image and converts it, in real time, into an output image with light from another source. In the case of the 12K, the other source is a 7.4K Xenon bulb, and the initial low-intensity information is derived from three infrared CRTs — one for each red, green and blue channel. Each CRT raster is imaged onto its corresponding ILA-LV through a relay lens. The Xenon beam is separated into its primary hues with dichroic mirrors, and each beam is linearly polarized by a McNeille-type polarizing beam splitter (PBS) before reaching the ILA-LV. The two sources are compounded together and focused through a lens onto the screen. The raster range of the CRTs can be altered to project different aspect ratios, from 1.33:1 to 2.4:1. At present, the ILA-12K is a 60Hz, 30 fps projection incorporating 3:2 pull-down. The company can later adapt to a 24 fps progressive scan.

The TI's DLP projector incorporates a theatrical lamp housing with their Digital Micromirror Device (DMD) technology, a semiconductor microchip with an array

of 1,300,000 tiny aluminum mirrors (SXGA) that act as optical switches by rotating mechanically to reflect light toward or away from the projection lens. The DLP mounts to the front of the lamp housing, and works off the illumination from that source. The light is projected into the DLP, split dichroicly into its three primaries, and then reflected onto one of three DMDs (one each for red, green and blue). A microchip receives information from the hard disk array and coordinates the 1.3 million mirrors, updating their positions. "Basically we have a memory under the mirrors, and we load that memory up to 50,000 times per second" explains Paul Breedlove, TI's program director for digital imaging. "We put a frame of data [from the hard drive] in the memory and break it down into pixels to determine the hue and intensity of each pixel. That hue and intensity is presented by varying the amount of time that the specific mirror is 'on' or 'off' during the period of that frame. The DMD may turn a mirror 'on' and 'off' up to 50,000 times in 1/24th of a second to get the color shade it needs.

"With our technology," Breedlove continues, "progressive and interlace doesn't have any relevance. We show an entire frame at a time, 24 fps. There is no scanning going on, so you don't see scan lines." The DLP Projectors have a native resolution of 1280 x 1024, and the 2.35:1 aspect ratio for the presentation of *The Phantom Menace* was achieved through an anamorphic projection lens.

"This revolution is no different from just five years ago, when digital nonlinear editing arose," submits McCallum. "The opposition to that was tremendous, but five years later, every studio and every television station has changed their minds. I know [accepting digital projection] is going to be challenging, but the truth is that the future is here — it's now." ■

scene all afternoon in full light, and then be prepared to shoot all of the required angles by rolling with 10 cameras at once, right at the magic moment when the sun was sitting on the horizon. We got two takes."

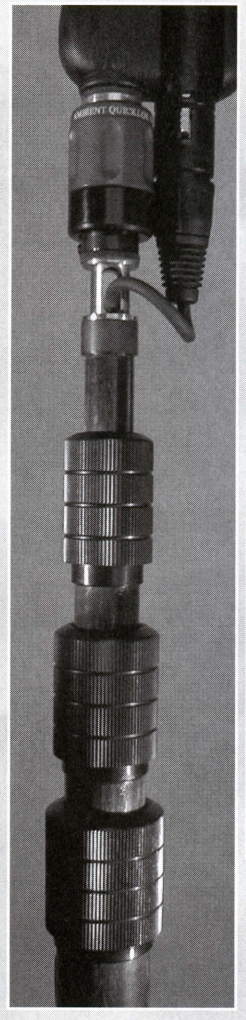
Aiding in Tattersall's work throughout the shoot was visual effects supervisor John Knoll, who acted as ILM's eyes and ears. "In early preproduction, Gavin, John Knoll and I enjoyed a rather close collaboration," the cinematographer recounts. "That was necessary because we all had to know what the bluescreen elements were going to be, and what ILM needed from us. In regard to the photography, it was a matter of referring to storyboards and any other visual reference material, and then establishing what might appear in the bluescreen later.

"That was helpful when we were shooting the Jedi Council Chamber. The set was used in three scenes, each of which took place at different times of the day — daytime, sunset and nighttime. Because of the chamber's huge floor-to-ceiling windows, a lot of planning went into both the lighting and bluescreen work. We had to find the best place to position the setting sun, and then determine how its light would work best for the drama of the scene. I would try to emulate that sort of lighting on the set, which ILM would match with their background plates."

On that set, "we were able to make sure we had the 15' we needed between the bluescreens outside the windows and the lighting rail from which we'd hang our pods of Jack Flos," Tattersall continues. "The bluescreen almost totally surrounded the set, covering nearly 300 degrees. Also, those windows were quite large, and which would theoretically allow quite a lot of light to come into that room during the day. That was a difficult illusion to create, considering that the bluescreens obscured so much.

"To get around them, the bluescreens were never hung directly

THE PROFESSIONALS CHOICE



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Phantom Camerawork

from the the overhead lighting grid, but with at least a 4' gap between the two. Behind the bluescreens we had a catwalk, from which we lit through the windows of the Council Chamber — coming in from up high through that 4' gap between the screen and ceiling.

"We had a lot of 9-light Mini-Brutes up there, along a rail surrounding the entire set. A diffusion screen was then placed in front, following the circumference of the lighting rig. Then, off to the side of the camera, we had other soft sources for fill, including a 12' by 20' silk screen with Maxi-Brutes behind it.

"That was the basic setup, but we could use it to create all three of the looks we needed in the Council Chamber by adjusting the direction, color and contrast of the lighting. For instance, the daylight sequence was full, white, soft and high-key. The sunset effect was more contrasty, with a harder, lower key gelled with ½ CTO and some ¼ CTB on the fill. The nighttime scene was then totally lit from practicals built into the set."

"Another interesting situation in which we dealt with large bluescreens and interactive lighting came up while we were filming Anakin's ship during the Podrace on Tattooine," Tattersall says, referring to the *Ben-Hur*-style contest that pits young Skywalker against his arch-nemesis, Sebulba. "We shot that with [actor] Jake Lloyd sitting in a full-scale pod mockup, which was on a gimbaled rock 'n' roll base. We had a map that showed the route of the race, so we knew when he would be flying across wide-open spaces with plenty of sunlight, though narrow canyons, under stone arches, and through tunnels. We then had to re-create the interactive lighting characteristics of those different areas on the race circuit, including nearby explosions caused by other pods crashing into canyon walls and so forth.

"Eddie Knight and I came up

Continued on page 76

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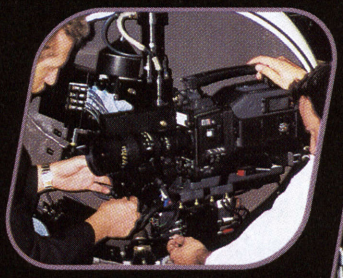

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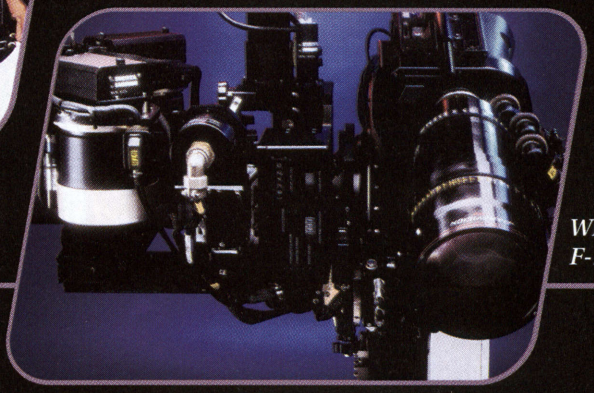

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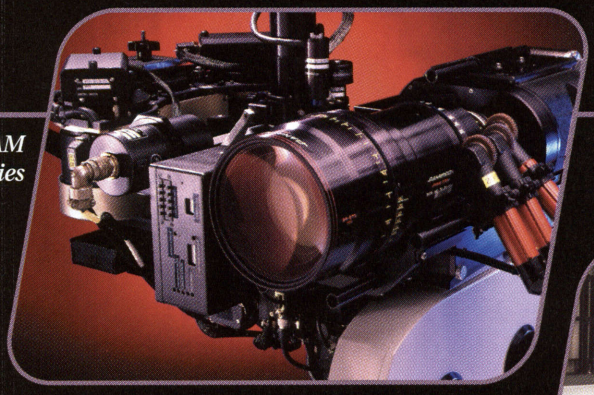

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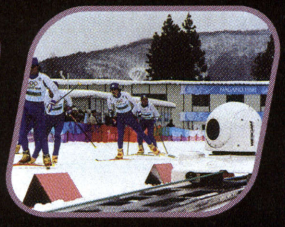

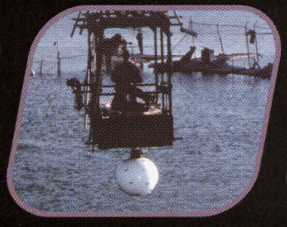

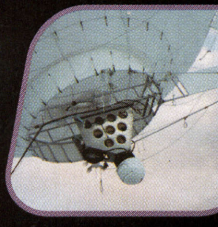

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HANDS-ON SERVICE

Arri Media takes rental business to the next level by providing personal touches.

by Jay Holben

A subsidiary of the Munich-based Arriflex Corporation, Arri Media of the U.K. is one of the company's primary European rental facilities, and it has made a name for itself worldwide, partly due to its extraordinary dedication to service.

The Phantom Menace was a reunion for Lucasfilm and Arri Media; the companies had previously combined forces on the ambitious television series *The Young Indiana Jones Chronicles*. Arri Media not only provided the gear for the globe-trotting production team, but an extra level of personal support for the crew. When it came time to shoot *Episode I*, producer Rick McCallum again turned to his fellow Brits for help.

"We're a fairly tightly knit company," offers Philip Cooper, Arri Media's rental manager. "Everybody knows what's going on with each show, and that's crucially important to us. We operate between 6 a.m. and 10 p.m.; there's always a trained technician at work during those hours. Beyond that, we have pager systems with emergency numbers, and we're available 24 hours a day. That way, when a production calls with a question, someone is there with the answer."

This concept of above-and-beyond support for productions led to the creation of the "crew-support technician" position within the company. When a production comes to Arri Media, they are presented with a support technician, who then personally handles that crew's technical concerns. When the production calls the rental house with a problem or question, the same support technician deals with the issue at hand. "It gives the crew peace of mind to know that they have someone in the rental house to whom they can turn whenever they have a problem," continues Cooper. "The crew-support technician is the most important position that we have. Each is a qualified Arriflex engineer. That way, if a crew has a problem, they're talking to someone who intricately understands the ins and outs of the gear."

In the case of *Episode I*, Arri Media's support began in preproduction, when technical manager John Duclos and camera support technician Andy Subratie took their gear into an environmental chamber to analyze the possible affects of the intense heat of the Tunisian desert — *Phantom*'s most inhospitable shooting location.

The Arri Media team was also involved in the creation of the Data Capture System (see sidebar on page 62) and the Integrated Video Assist System (IVS), which had been completed at the request of Industrial Light & Magic for the film. When production began at Leavesden Studios, John Duclos was frequently on the set. He recalls, "Since a lot of the gear that was used on *Star Wars*, like the DCS and the IVS, was brand-new — some of it was delivered to the production literally a day or two before shooting began — we were writing the manuals right on the spot!"

Duclos and Subratie remained constant members of the *Phantom* crew, and were on set nearly every day to make sure that everything was working smoothly. They were also able to quickly step in when something wasn't. "For the most part, the crew-support tech will visit the set a couple of times in the first week to help the crew get settled," Cooper explains. "But more than once, after that first week, productions have come back and said, 'Can we keep him?' To them, it's like an insurance policy. They've got someone there who can strip the cameras down if necessary and keep things running. That's what happened with Andy [on *Phantom*]."

When it came time for the company to move to Tunisia, they asked to take Subratie with them into the desert. Luckily, he went. "The first day in Tunisia, we had a problem with the dollies," Subratie recalls. "At some point during transit, air had gotten into the hydraulics of both dollies, rendering them pretty much useless. Although it's a simple procedure to remedy, no one on the crew had the experience or proper tools to take care of it. I was able to go to work right away on the problem. As a result, the dollies didn't have to be sent back [to Arri Media], and the production didn't have to wait for others to be sent out. The crew continued doing what they needed to do while I got the dollies back to working order. That's the main idea. It isn't that the crews can't do what we do — we just remove the burden from their shoulders to let them keep doing their normal jobs.

"In the high heat of Tunisia, we had a problem with the film emulsion literally melting in the gate, which became something I was able to deal with," Subratie continues. "It wasn't just Arri gear that fell into my hands, either; I lent a hand wherever I could, whether that meant working on other gear, or even loading film when time was short. The VistaVision cameras that ILM supplied were pretty old and didn't handle the heat very well. I had never seen a VistaVision unit before, but I was out there working on them constantly, and doing whatever else I could to keep the show running smoothly." ■

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Вызволение тележурналистов с острова Врангеля может с

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NHK team rescued from Arctic

MOSCOW (Kyodo) A three member team from Japan

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n the island for about three months.
and in early September to film a doc-
e ecosystem, including polar bears,

Last bid to rescue Arctic film crew

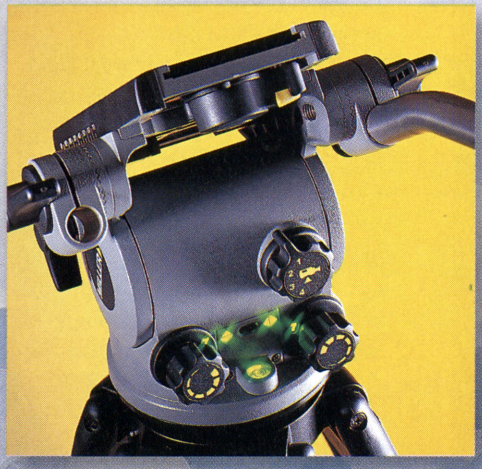
BY SUE MASTERMAN

rescuers were stranded in a howling blizzard at minus twenty degrees. Rebecca Scott, the partner of Australian film maker Rory McGuinness, told a Melbourne radio station: "I think this week is probably the last window of

Making news

Arrow 50

making news



"The Arrow 50 retained the subtlety of control on the drag settings and kept functioning smoothly in the worst conditions".

Cinematographer Rory McGuinness made news recently when he was stranded for six weeks on an island in the remote Siberian arctic. While awaiting rescuers, Rory kept shooting the polar bear documentary in conditions that made incredible demands on crew and equipment.

"We had minus 25 to 30 Celsius, plus windchill, but while we had filmstock and bears we just kept shooting. It soon sorted out the gear. Some of it froze solid, while other things just kept going. The Arrow 50 retained the subtlety of control on the drag settings and kept functioning smoothly in the worst conditions".

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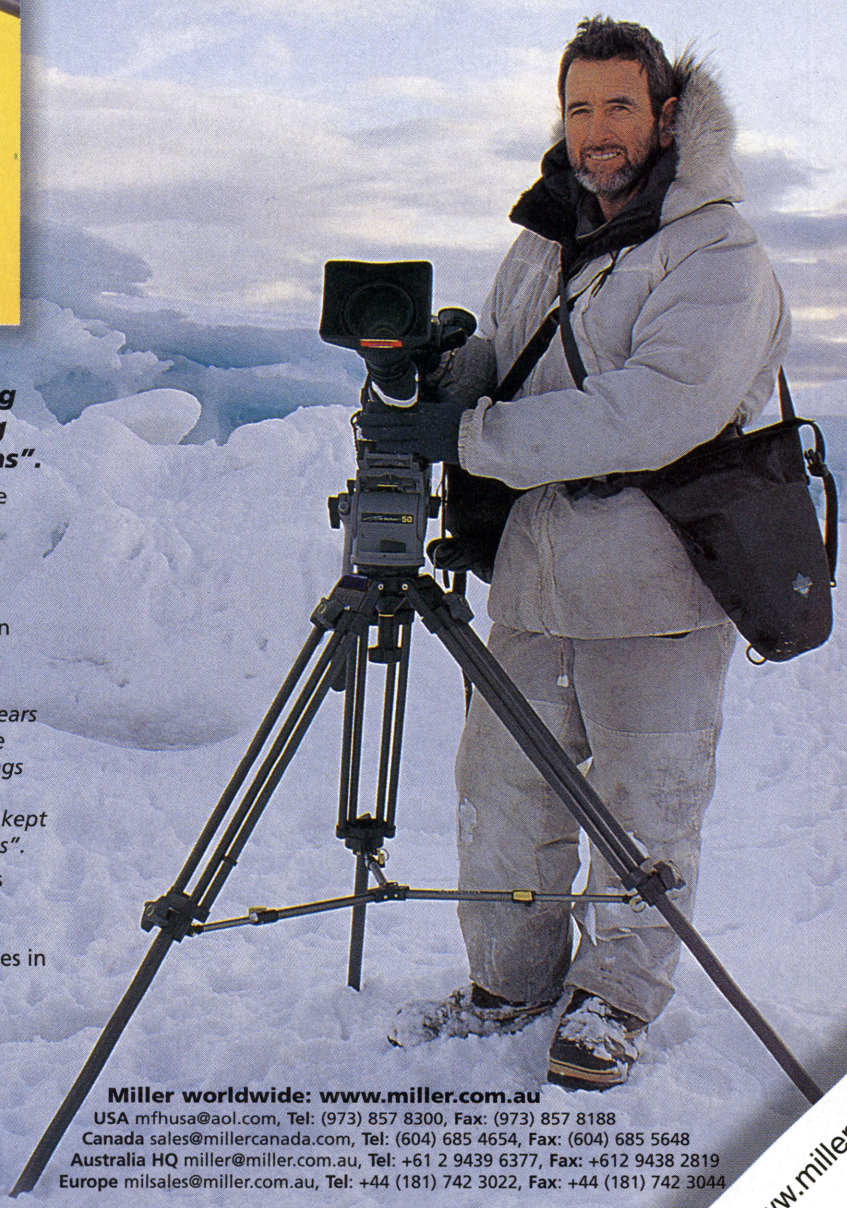

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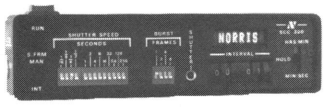
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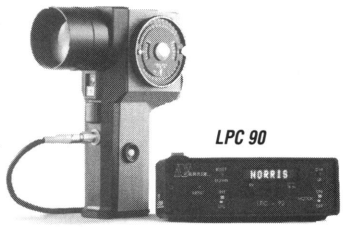
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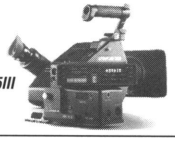
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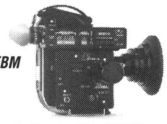
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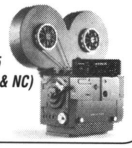
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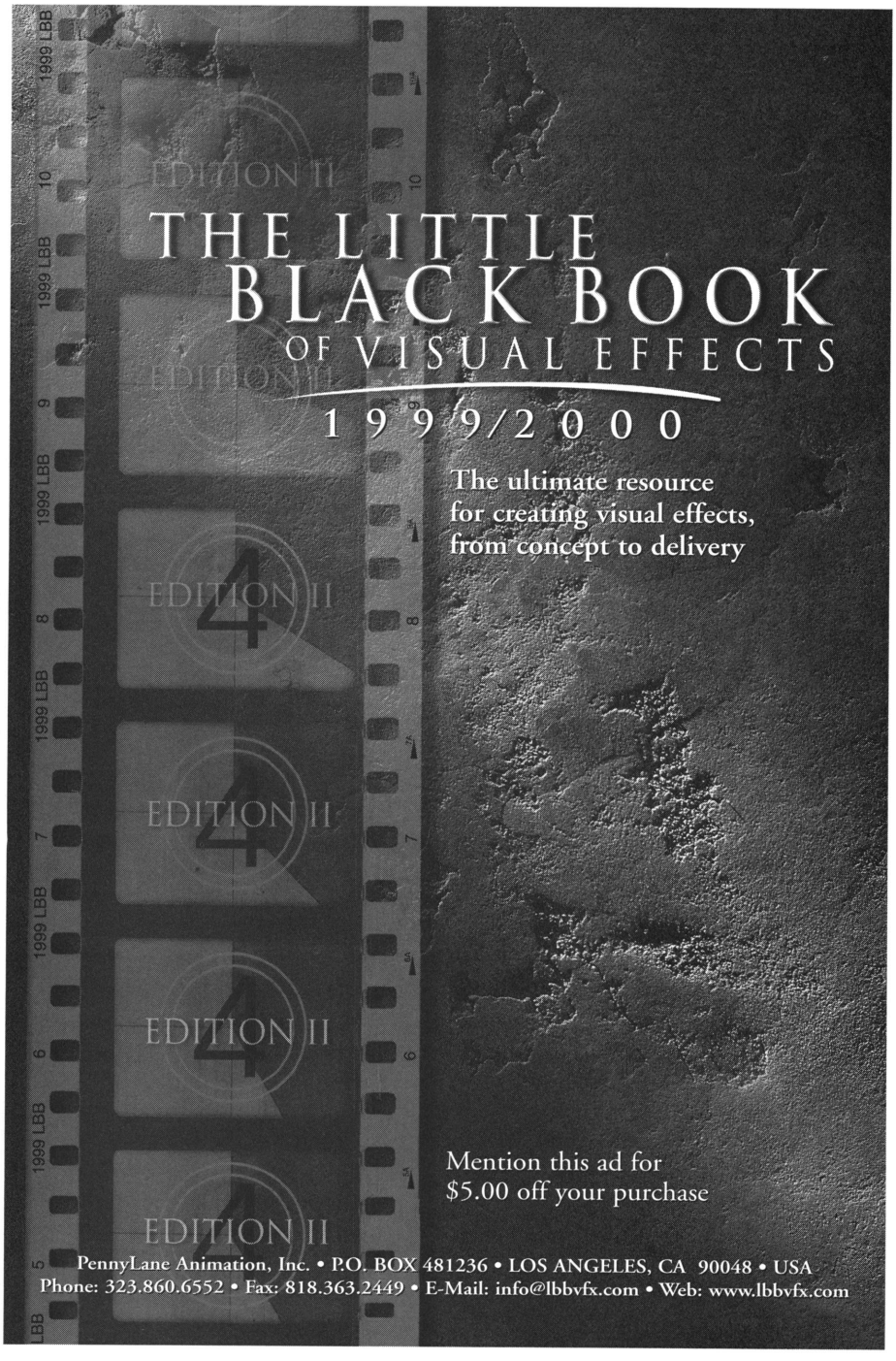

Phantom Camerawork

with several different lighting rigs. One was just a full 20'-diameter circle that hung over Anakin's pod on the motion base. Suspended from the circle on a track was a 5K, which could be swung around the pod to give the impression that Anakin was sailing around a corner. Another rig was built as an arch over the top of the pod; it was fitted with a rail so we could swing a 5K from being a left-side crosslight to a position where it became a right-side crosslight, which gave the impression that Anakin was swaying back and forth.

"There were additional lighting cues running on dimmers, so we could switch from a soft toplight — suggesting flying over open ground — to a flashing, strobing quality that simulate flying through the arches. All of these effects were cued and ready, so George could simply call out, 'Now we're going through the canyon!' or 'Now somebody blows up' or wherever else was needed."

Knowing that the entire film would be digitized allowed Tattersall a great degree of freedom to place lights in positions that might otherwise be in frame, but "it was still a scary notion, because you can sometimes later inherit aberrations and color shifts that can create grading problems." The cameraman adds that having reference material taken from any given shot or sequence, before it is put through the digital effects phase, is vital to retaining the integrity of the original material.

Looking back on his experience in the *Star Wars* universe, Tattersall again credits the artists at ILM with completing what he and the principal production crew captured on film. "Their contributions to this film were really colossal, and that's no exaggeration," he enthuses. "Considering the number of individual effects artists of all kinds who worked on the film there, the picture has a stylistic unity that's truly exceptional." ■

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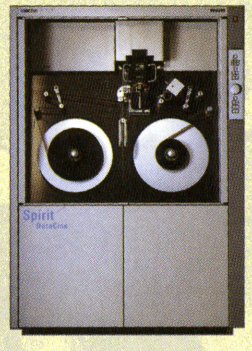

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Effects Jedi

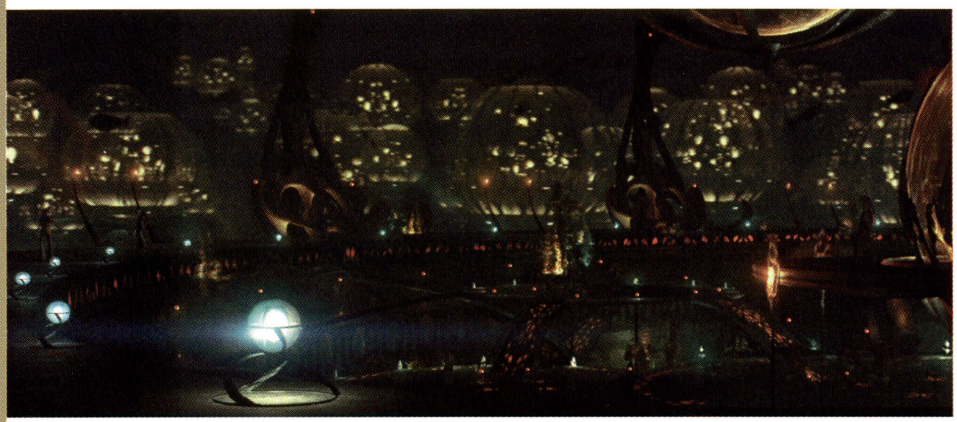
The vast scale of *Episode I* demanded the combined efforts of three visual effects supervisors and their respective teams.

by Ron Magid

Unit photography by Keith Hamshere, Giles Keyte and Jonathan Fisher

The feature-film followup to the original *Star Wars* trilogy had been brewing for 16 years, and even those closest to George Lucas had begun to doubt that it would ever happen. After the success of the trilogy Special Edition releases in 1997, however, Lucas officially announced that he was back in the *Star Wars* business.

In attempting to reshape cinema — from a production-based medium into an elaborate postproduction process — Lucas was eager to test the capabilities of his fabled Northern California-based visual effects facility, Industrial Light & Magic. Lucas set the trial's parameters: he would direct *The Phantom Menace*, and through his own personal experience, determine whether or not digital cinema was ready for its close-up. To give audiences a taste of technology's ever-increasing power to transport us to a thousand different worlds, Lucas deliberately created the biggest effects project ever.



Any single aspect of the visual effects work seen in *The Phantom Menace* — be it a space battle, a ground battle, a computer-generated character or a digital set — features enough work to fill the average effects-heavy summer film. Combined, these sequences represent an unparalleled cinematic undertaking. In fact, it's easier to spot the few hundred shots that don't feature any CG work at all than the nearly 2,000 shots that do.

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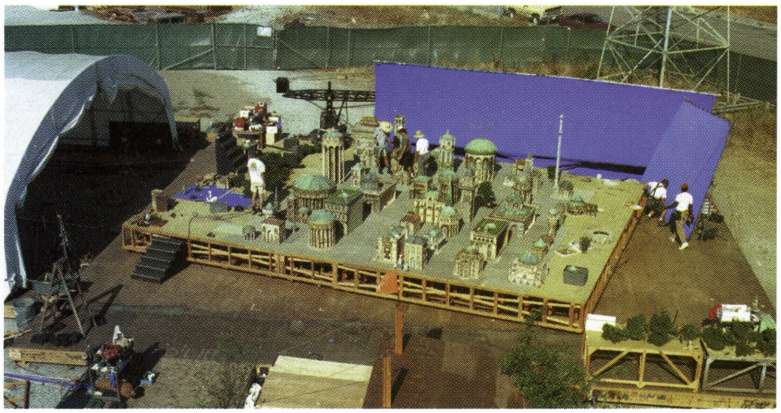

Opposite, top: Visual effects supervisor Dennis Muren (left) and model supervisor Steve Gawley inspect a Federation Attack Tank. Muren was primarily charged with overseeing the Otoh Gunga underwater-city sequences (opposite, bottom) and the Gungan/Battle Droid confrontation on Naboo. This page, far left: Filming the city of Theed miniatures at ILM. Visual effects supervisor Scott Squires (near left) oversaw this work, as well as the picture's many other virtual environments.

It wasn't just the sheer number of effects shots that made this new *Star Wars* adventure so daunting. Equally imposing was the scale of the entire enterprise, which demanded the utmost from a talented group of artists, who began working from exceptional conceptual designs, storyboards, and digital previsualizations. Principal production, scale-miniature work, and effects photography followed, and the resulting pieces of the intricate *Phantom* puzzle (including key segments depicting purely CG characters, events and locations) were assembled by animators and compositers who pushed industry-standard software tools such as Softimage and Alias Wavefront's Maya and Renderman, as well as Silicon Graphics and NT workstations, to new limits.

Although nearly every aspect of the production was planned in elaborate visual detail almost from the scripting stage, the assignment of the film's dozens of visual effects sequences involved a good deal of gut-level decision-making. Given Dennis Muren, ASC's participation in the original trilogy, one might expect that he was the first effects supervisor hired for *The Phantom Menace* — after all, Muren had earned two of his eight Academy Awards for *The Empire Strikes Back* and *Return of the Jedi.* "No," Muren says emphatically. "George talked to me early on about doing *Episode I,* when I was still working on *The Lost World* [in 1996]. They didn't quite know how they wanted to set the show up, I wasn't sure what I was going to do on it, and I couldn't run off to a location to start shooting background plates for it. However, I knew that John Knoll really wanted to work on it, so I told George, 'You really should get one person on the show for now, and I think it ought to be John.'" (Muren eventually did join the show after completing his work on Steven Spielberg's dinosaur blockbuster.)

Knoll was riding high at ILM after re-creating or enhancing most of the original trilogy's space-battle sequences for the Special Edition releases (see *AC* Feb. and April '97). Based on Muren's recommendation, Lucas handed Knoll the formidable task of creating virtually all of *Episode I*'s space-set effects. "I thought it made sense to group things by type," says Knoll. "In addition to the film's climactic space battle, I took on everything else that happens in space: the blockade of Naboo, the Republic Cruiser docking on the Federation Battleship, and all of the scenes with the Nemoidiens on the battleship's bridge. I also supervised the action with the Jedi knights in the conference room and the corridors, as well as the assault on the Queen's Ship and the Federation invasion."

It sounds like more than enough for one person to handle, but Knoll surprised even the normally unflappable Lucas by asking for *additional* work. "Looking through the storyboards, I really wanted to do the Podrace," he states. "Therefore, it made sense for me to do all of the other things that would happen on Tatooine as well. I took on all of the desert scenes, including the landing of the Queen's ship, and the meetings with Watto, Sebulba and all of the other CG characters. I was the first one on the show, so I made a shameless grab at the stuff I wanted to do!"

Knoll's grasp only slightly exceeded his reach when he also asked to tackle shots of the steel-and-glass megalopolis of Coruscant. "I made a grab for that as well," Knoll admits, "but when we totaled everything up, I found myself responsible for something like 1,300 shots!" Reluctantly, he agreed to share Coruscant with visual effects supervisor Scott Squires (*Dragonheart, The Mask*), who also reimagined the arid squalor of Tatooine's city of Mos Espa and created baroque settings for Naboo's royal city of Theed, including the Starfighter Hangar, the Throne Room, various hallways, and the Generator Room beneath the palace, where the story's climactic lightsaber duel occurs. Squires' portion of *Episode I* amounted to a whopping 600 shots, which were largely created using traditional miniatures and digital matte paintings. Again, his task alone amounted to far more work than the average ILM effects project.

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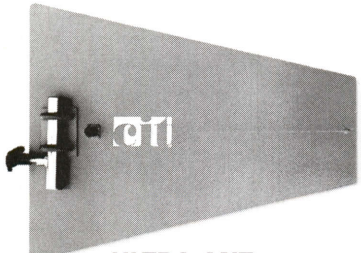

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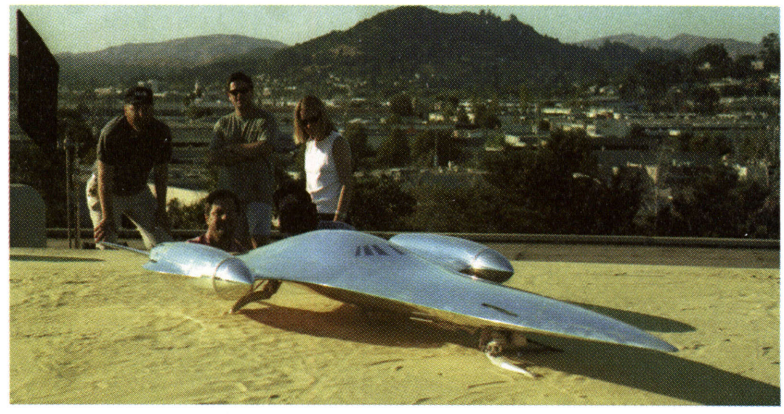

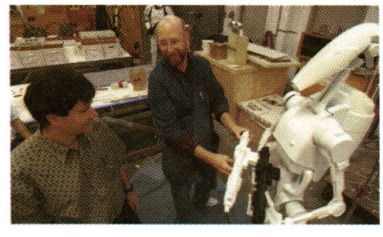

Above: Filming the Queen's ship within a Tatooine landscape. John Knoll, the first visual effects supervisor to join *Phantom* (at far left in bottom photo, inspecting a Battle Droid mockup with Steve Gawley), largely oversaw the space-set and Podrace sequences.

Squires is hard-pressed to remember exactly how he ended up with the enviable task of creating many of *Episode I*'s virtual environments. "I'd gone through all of the storyboards, but I didn't really come on the show as an active principal until after the plate shoot was done," he recounts. "At that point, many of the basic miniatures had already been built. For the purposes of our team, however, many of the big set-construction elements had to be built after the fact anyway."

With typical clarity, Dennis Muren remembers exactly what attracted him to Lucas's hyper-ambitious project. "I was most interested in the Gungun underwater sequences and the ground battle," he relates. "Everyone was very happy that I was interested in those setpieces, because nobody knew quite how to handle them."

Muren says that he had wanted to do an underwater sequence ever since seeing Rhythm & Hues' work on the simulator ride *Seafari* five years prior. "Doing the Gungan city [and submersible scenes] was a neat opportunity to do something set underwater, where we could really linger on shots with creatures and everything. Also, those scenes were completely different from the big battle sequence at the end of the film, in which 5,000 Gunguns fight off 5,000 Droids."

Muren's eagerness to create imagery that others had thought impossible explains both his longevity at ILM and his inexorable rise to the top of the effects field. "A lot of people who saw this stuff were terrified, but I saw it as an opportunity," says Muren, who has since become the first effects artist to receive a star on Hollywood Boulevard's Walk of Fame. (See page 152 of this issue for details.)

Thus, Muren took on some of the toughest shots in *Phantom* with the confidence gained from tackling and conquering so many previous "impossible projects." Nevertheless, he'd never worked on anything quite like *Episode I*. "People were coming off of other shows, and they were really tired, and I kept hearing, 'How are we going to get 2,000 shots done?'" Muren recalls. "Well, I wasn't sure how we were going to do it, either! But my thought was, 'It won't be 2,000 shots. George will cut them in half — which he had sort of done on the other shows — and we'll be doing 1,000 shots. It'll be hard, but

not impossible. . . ’”

However, while Knoll was in England working on principal photography, Muren and Squires began getting news from the set. “We were hearing that George was shooting everything he’d planned to do, and that he wasn’t cutting anything!” Muren reveals with a hint of remembered anxiety in his normally calm voice. “John had been saying, ‘We’ll start out at a sprint and just keep that high pace up!’ But I kept saying, ‘John, people are going to wear out!’ He was right, though: there was really no other way to do it. If we didn’t want to be finishing all of the work in the last three months, we had to start out with a pretty high shot count per week just to be able to get the thing done.”

“In the beginning, it was a very intimidating experience,” Knoll concurs. “On most shows done at ILM, there will be one or two aspects that haven’t been done before and that require us to push the envelope and develop something new. Of course, that was on top of the sheer huge *number* of shots. A lot of people thought, ‘We’ll never be able to do this!’ so I gave everybody a pep talk that I only half-believed myself. I said, ‘Think of it this way: the typical show is on about a nine-month to a one-year cycle. The first couple of months are the design phase, then we have the plate shoot, and then there’s an edit. By the time we actually get locked sequences and are really ready to begin production on the shots, we’ve got about three months left. The first part of that is ramping up, getting in sync with the client and agreeing on a look, so most of the real work happens in the last two months. Now imagine having 18 months instead of just two months! Think of what we can get done!’ Fortunately, they all bought into it and said, ‘Okay… I can *kind of* see that. We can get it done.’ And that’s almost exactly what did happen.” ■

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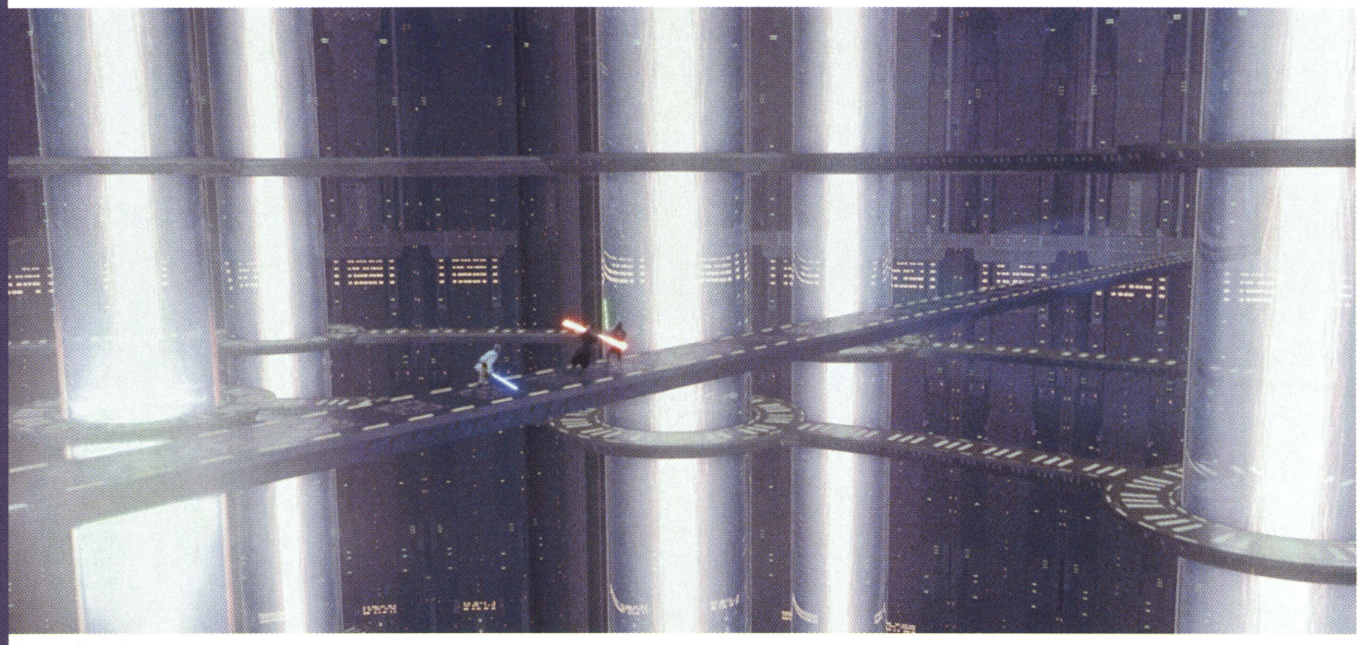
Virtual Realities

Synthetic architecture and vistas complete *The Phantom Menace*'s epic settings.

by Ron Magid



No aspect of *The Phantom Menace* is more spectacular than the diverse environments used as backdrops for the film's operatic drama. It's difficult to recall any other film with such individualistic settings, which include the art nouveau underwater Gungun city of Otoh Gunga, Queen Amidala's opulent royal palace, the stylish skyscraper-covered planet of Coruscant, and the arid deserts of Tatooine.

Of course, this array of jaw-dropping vistas is just what director George Lucas ordered. "George wanted the environments to be very different, because he planned to intercut quickly from scene to scene," explains conceptual artist Doug Chiang. "He wanted each location to be readable in terms of style and color, so that when we cut to a new scene, the audience would immediately know they were in a different environment altogether." This approach was complimented by the previously outlined division of work assigned to visual effects supervisors Dennis Muren, ASC, Scott Squires and John Knoll, whose individual talents would lend each locale a unique aesthetic.

Since the Tatooine spaceport of Mos Eisley was enhanced significantly for 1997's *Star Wars* Special Edition release, Knoll was able to repurpose many of the miniatures to create the planet's gambling capital, Mos Espa. Knoll reports, "There was a fairly good-sized street section of Mos Espa that was built full-scale on location in Tunisia, up to about 12' high; in a lot of shots, we only needed to extend a few building tops. Other shots required massive extensions off into the distance. Paul Houston had built a bunch of generic Tatooine buildings out of trash cans, foam core and all kinds of other stuff for the Special Editions, so we hauled those out and shot them again for this picture. We also built some additions; I think we doubled our collection of Tatooine buildings."

Coruscant is another location that debuted in the Special Editions, as part of the interplanetary celebration that now completes *Return of the Jedi*. Knoll's team, headed by matte artist Yusei Uesugi, created most of the dazzling exteriors for the gleaming glass-and-steel city, which covers the entire planet. Because there were so many shots featuring different angles of Coruscant's vast architecture, Uesugi began by creating CG

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models of some 30 or 40 key buildings. Knoll explains, "Yusei probably spent nine months just building models, then doing raytraces on top of them, so he had good lighting and texture bases. They amounted to a 'kit' from which we could build Coruscant. Those 30 buildings could be rearranged, and some of them looked a bit different if we rotated them 90 degrees, so we did a bunch of mixing and matching. Because we had a reasonably good variety, you don't see much repetition. Yusei would later go in and give the shots some matte-painting 'love,' although lot of the distant buildings were just crude silhouettes."

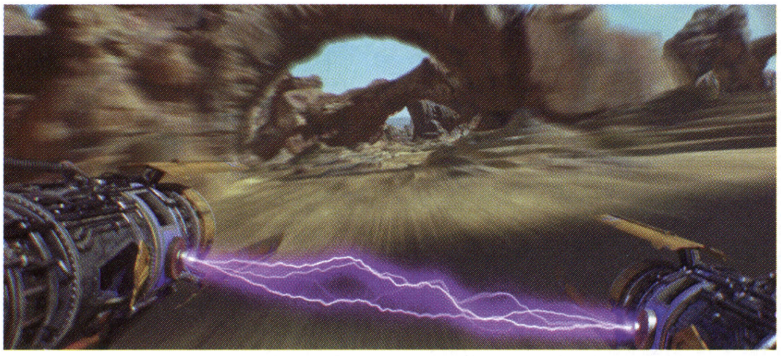
The spectacular God's-eye views of a floating Coruscant landing platform, upon which the Queen's chrome ship is poised, were entirely CG, Knoll reports proudly.

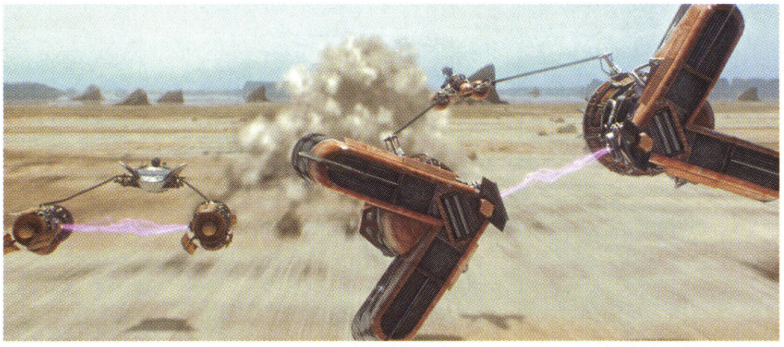
All told, Knoll's unit tackled 150 environmental shots to flesh out exteriors for Tatooine and Coruscant. Meanwhile, Scott Squires' unit took on several memorable Coruscant locations, including the Temple of the Jedi and the Jedi Council Chamber. Squires may seem an odd choice to handle primarily CG environments, since his expertise highlights character animation. However, he is quick to point out that "we did more than just the environments," noting that his sequences included working with Jar Jar Binks and various CG droids.

Of all the Coruscant locales, none is more dazzling than the Senate Chamber, a vast, pear-shaped dome lined with hundreds of seats filled with senators from a thousand different worlds. The seats are actually flying pods that can detach and descend to the central tower, where the senate's president, Chancellor Valorum, sits. This imaginative design created untold problems for Squires' team. "[At Leavesden Studios,] the production design team built the top of the tower — 'the Avocado,' as we liked to call it — about 12' up, and there was a bluescreen floor and a bluescreen behind it, so the crew had limitations on how they could move the camera around in that environment," Squires recalls. "For the shot in which Queen Amidala flies down to speak with Valorum, they had built one or two of the pods on tracks so two grips underneath could rotate them, but they couldn't photograph the real pod doing that type of move on stage.

"We ended up doing that back at ILM with a motion-control camera revolving around the actors, who were just standing on a couple of green platforms. Once the pod reached a certain point, the CG work took over, moving it down even further. There were also a number of cases where they photographed the pod framed very tightly or going partly offscreen; the editor then reduced that down in the Avid. Well, we were missing a quarter of the pod, so we had to replace it. We put a CG pod in, but the maquette, the blueprints and the setpiece were all different — they didn't match correctly. We ended up just pulling the actors out of the real pod, putting them in a CG pod, and just trying to make all of it match."

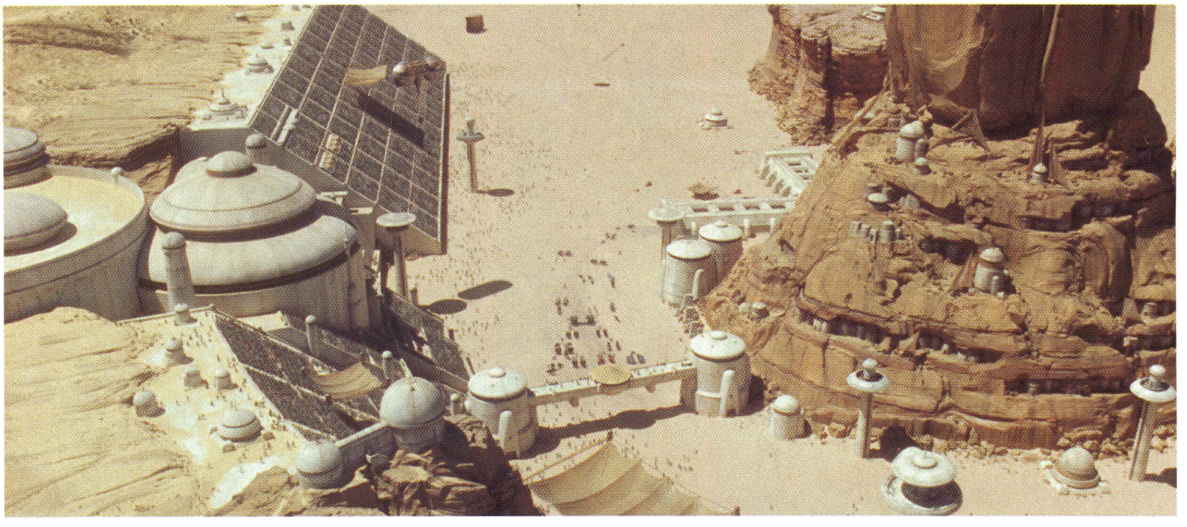
As for the rest of the senators seated in all those pods lining the walls of the chamber, "just about all of them were elements shot against greenscreen, along with a few CG

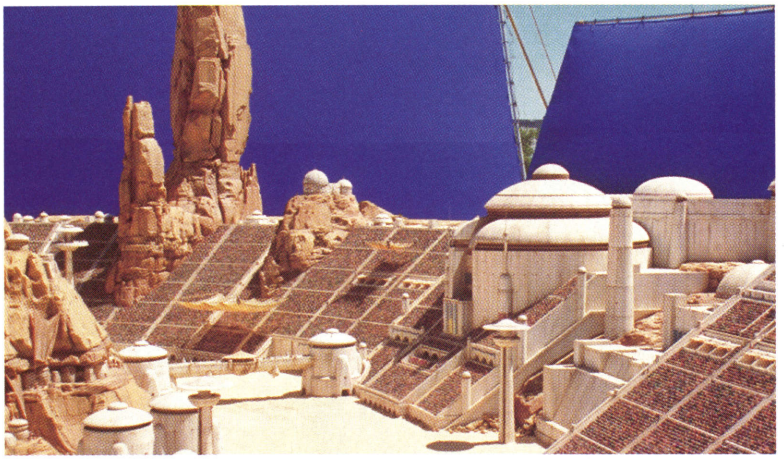


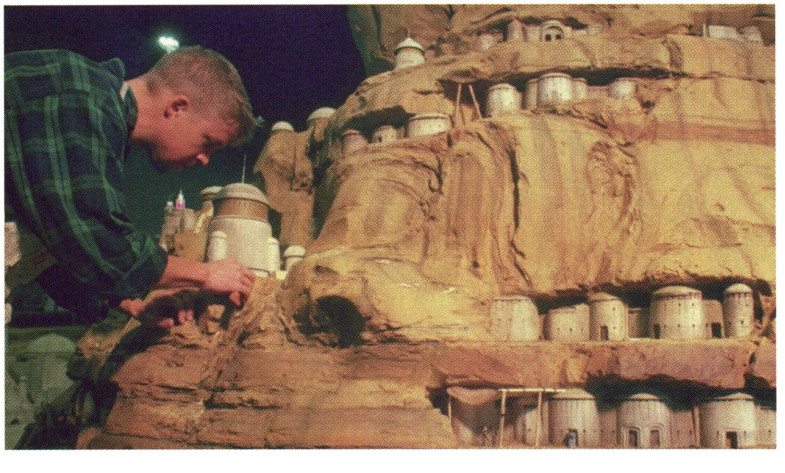


Opposite: The film's Jedi heroes battle with Darth Maul within one of *The Phantom Menace*'s most elaborate virtual environments. The actors, filmed on a bluescreen stage, were lit by cameraman David Tattersall, BSC with a series of Lightning Strikes units set to execute random chases, creating an intense interactive lighting effect, illumination ostensibly created by the massive energy tubes. This page: The topography of Tatooine for the Podrace sequence was created by building scaled-down tabletop sets and then photographing them to create texture maps that could be applied to a 3-D landscape.

Virtual Realities







The Anchorhead Arena is filled to capacity for the Podrace spectacle. An illusion created with impressive miniature work, the 90' x 30' stadium structure was photographed in bright daylight, with a crane-mounted camera simulating an aerial-style flyover for the impressive reveal and several subsequent shots. The crowd is largely composed of Q-Tips dyed in various hues, while CG spectators, vehicles and race participants were added later. Still photos were also taken of the miniature and later used as background plates for static shots within the lengthy sequence.

characters," Squires reveals. "We built a platform and set up four digital-video cameras, one above the other. We then had the extras go through their actions, after which we rotated the camera rig and asked them to perform different actions. We ended up with umpteen elements and gigabytes of data. Those people elements were then placed on cards in the 3-D world within each of those pods, so they were in the correct perspective. They are, in fact, moving, although you may not see them too well in the wide shots."

Rendering Qui-Gon Jinn and Obi-Wan Kenobi's swim to the Gungan underwater city of Otoh Gunga, as well as their submarine ride through Naboo's cave-riddled planet core, pushed pixels to their limit. Dennis Muren offers, "This was a chance to get back to [the degree of work we did for] the speeder-bike chase in *Return of the Jedi.* Most of the shots in that sequence were completely artificial, which gave me a lot of control. I like setting up entirely synthetic sequences, because then I'm directing where the audience's eye is from the beginning to the end — as opposed to shooting live-action background plates [and then adding effects], which is what I'd done on *The Lost World.* I didn't deal with plates at all for most of my shots — we were creating the whole frame. That was valuable in working with George, because he likes to tweak things until the end, to help the continuity or the credibility of a sequence. If we're not stuck with plates, we can go back in without too much difficulty and make changes."

Of course, visualizing a completely synthetic sequence, in which just about anything can happen, takes a great deal of discipline. "I got an idea of the direction of the sequence from all of the preproduction work that George and

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EPISODE I

THE PHANTOM MENACE

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A nighttime view of the Jedi temple on the cityscape planet of Coruscant. An illusion created with scale models surrounded by a digital cyclorama landscape, this shot hews closely to art director Doug Chiang's original design.

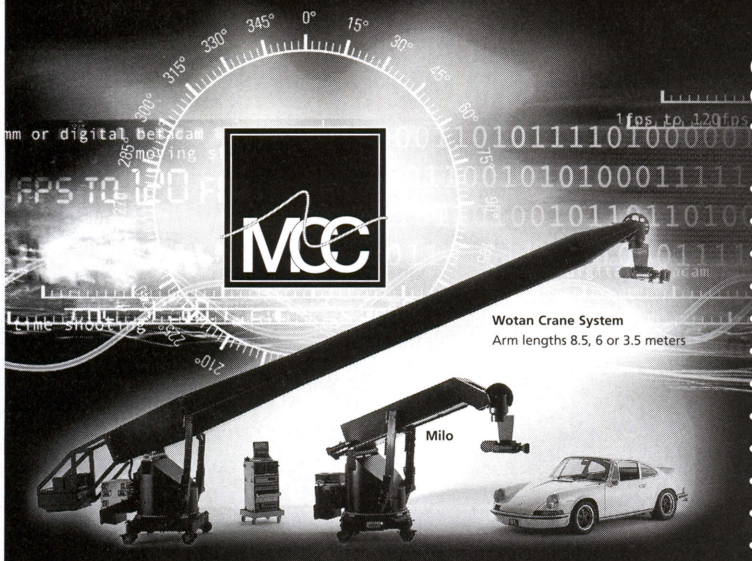
Doug [Chiang] had done," Muren says. "I then revised a few of the animatics that had been done [by previsualisation/effects supervisor David Dozoretz] to reflect my sensibility. I picked the angles and made sure that each shot had something interesting to look at. George would then look at those and say, 'Oh, the camera should be back a little bit farther' or 'A little closer on this.' It was a matter of getting into everyone's heads and then giving the scenes a style that I like, which pretty much had to come from me emotionally; I don't think that's an intellectual process."

Muren envisioned a dramatic revelation for our first look at Otoh Gunga, seen after Jar Jar leads Qui-Gon and Obi-Wan on an impromptu swim. "I wanted to make the approach to the city look really neat, coming over the edge of a cliff for the reveal," Muren relates. "The city itself looked something like a huge chandelier. George's idea was to make it this glowing, beautiful, very organic-looking place. All of the curved shapes were in the art-nouveau style, which is actually based on the growth patterns of nature. The idea was that the Gunguns have grown those buildings and come up with a way to create shields so that the water doesn't get in. We just wanted the city to look magical and to keep that sense of serenity and beauty."

Muren and design director Doug Chiang brought in digital matte artist Brian Flora to develop Photoshop concept paintings of the unusual Otoh Gunga environment. "When I first saw the storyboards, I was reluctant to do the shots, because I couldn't visualize how it was going to look interesting and real," Flora admits. "Otoh Gunga is an unusual environment comprising repetitive spherical shapes. The challenge was coming up with a lighting scheme that made all the design elements fit together without looking overly complicated. To start, I looked through a lot of book and magazine references until I found lighting that appealed to me and fit the scene. I found some pictures in a book of Paris at night, and there was all of this green light arcing up underneath architectural shapes. I used that as a color basis for the environment."

The Otoh Gunga interiors involved some plate photography, due to important dialogue scenes between the Jedi duo and two CG characters — Jar Jar and Gungan leader Boss Nass. Muren didn't enjoy this sequence quite as much: "I hate to say this, but the city interiors were sort of run-of-the-mill. We just built the environment up by adding bubbles and fish swimming around outside the windows. However, it was difficult to get those bubbles to look as if they were glowing."

Flora also found it difficult to distinguish between what was inside and outside the bubbles of Otoh Gunga. "I used atmospheric perspective to suggest depth and enhance perspective," he says. "As objects get further away from us in the distance, they get progressively obscured by atmosphere. This effect, in conjunction with the dramatic lighting, really



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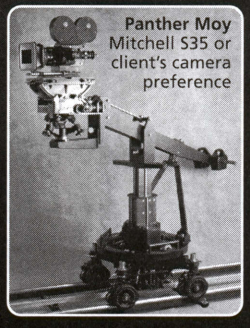

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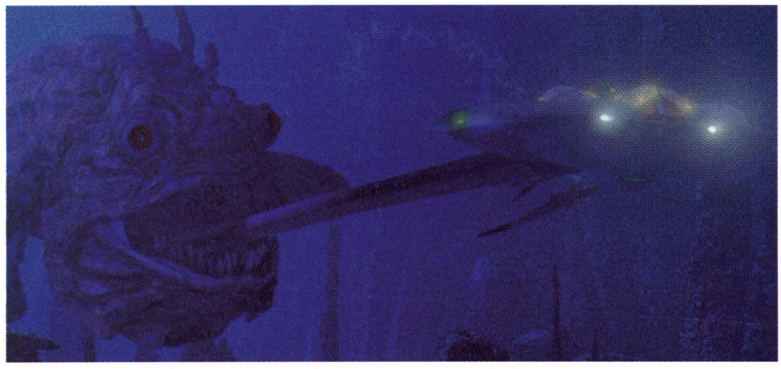

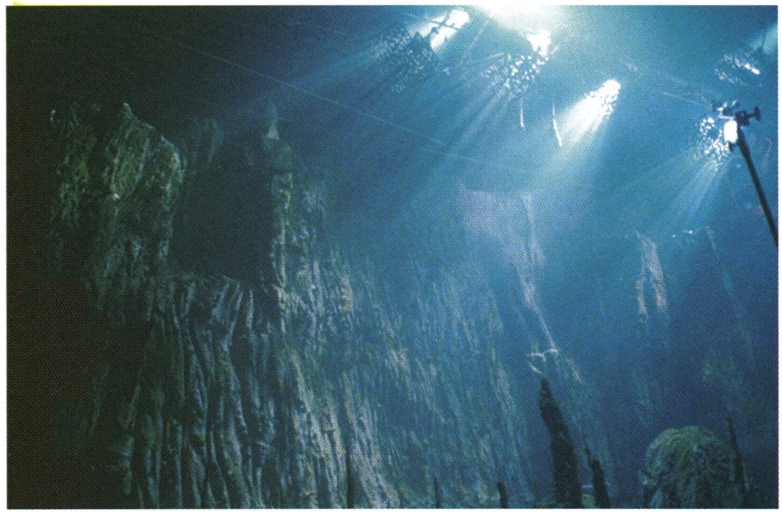

A crab-like sea monster takes a bite out of the Gungan sub carrying Qui-Gon Jinn, Obi-Wan Kenobi and Jar Jar Binks. The vehicle and creature were computer-generated, while the rocky seascape background was photographed dry-for-wet with motion control on a smoke-filled stage. CG particulate matter was later added to further establish the deep-water environment.

helped give the interior space scale. To make the platforms and ribs that support the globes, I used software that allowed me to sculpt organic-looking shapes. This enhanced the art-nouveau look of the Otah Gunga Plaza environment."

Although the Jedis' approach to and departure from Otoh Gunga is a completely synthetic sequence, it still required a fair amount of traditional photography. "There was so much CG in the film that I didn't want to burden the CG department with things we could do in other ways," Muren says. "We had a model crew of 100, so it was pretty easy to pull out 50 shots and do miniature backgrounds for them. All of the cliffs surrounding Otoh Gunga and the Naboo caverns were models measuring about 10' tall."

Visual effects director of photography Marty Rosenberg shot these landscapes dry-for-wet, using a smoke-filled environment to create the proper "underwater" feel. Muren experimented with several lighting approaches. "I wanted to try going with all sorts of interesting colored lights in the rocks, but it ended up looking like a theme-park ride," he says. "I thought it might look *Star Wars*-ish, but in fact, it just looked fake. Instead, we went more with the classical, toplit blue-gray smoke to create the underwater look. We then put in all of the CG particles, the three sea monsters, and so forth."

Muren's primary changes to the previously devised animatics for this sequence dealt with how to depict the massive creatures that rule the depths of Naboo beyond Otoh Gunga. "I tried to make the lobster-thing that grabs the sub — we called it Opee — look big and scary by moving the camera in close and making it look as if it's so big that you can't get it all in frame," Muren details. He used the same compositional approach to magnify the terrifying T-rex in *Jurassic Park*. "I think that's an important rule. That way, when a dinosaur-like creature, Sando, swallows Opee, it just makes him look that much bigger!"

As cool as his CG monsters were, Muren was always mindful of the dramatic arc of the sequence. "We had live-action shots of Liam Neeson and Ewan McGregor [with Jar Jar Binks added later] in the sub's cockpit, and the rhythm of the sequences was set up by their dialogue," Muren states. "When we cut to the outside, we didn't want to linger too long and make it an effects sequence. That way, the audience is interested in 'Are they going to get away or not?' rather than how neat the creatures look. We tried to make the audience want to see a bit more than we allowed, making the shots of the creatures a little shorter than the viewers might like them to be."

Visual-effects supervisor Scott Squires' unit took over the effects chores from the moment the Gungun submarine surfaces in the bay near the Royal Palace in the Venetian-style merchant city of Theed. Like Muren had on the underwater sequence, Squires concluded that Theed should be partially achieved via elaborate miniatures. "Because of all the texturing detail on those buildings — the flowers and things, the outdoor lighting, and just trying to balance resources throughout the sheer volume of shots — the thought was, 'Let's go ahead and build as much of the city as possible as a physical model,'" Squires recalls. Marty Rosenberg photographed the models, with additional visual effects supervisor Scott Farrar pinch-hitting for Squires for a few weeks. "The model unit was originally going to build about 60 different buildings, but we ended up with well over 100, all at 1/30th scale," says Squires. "All of the Theed exteriors are miniatures, so we had an entire collection of buildings for each setup, some of

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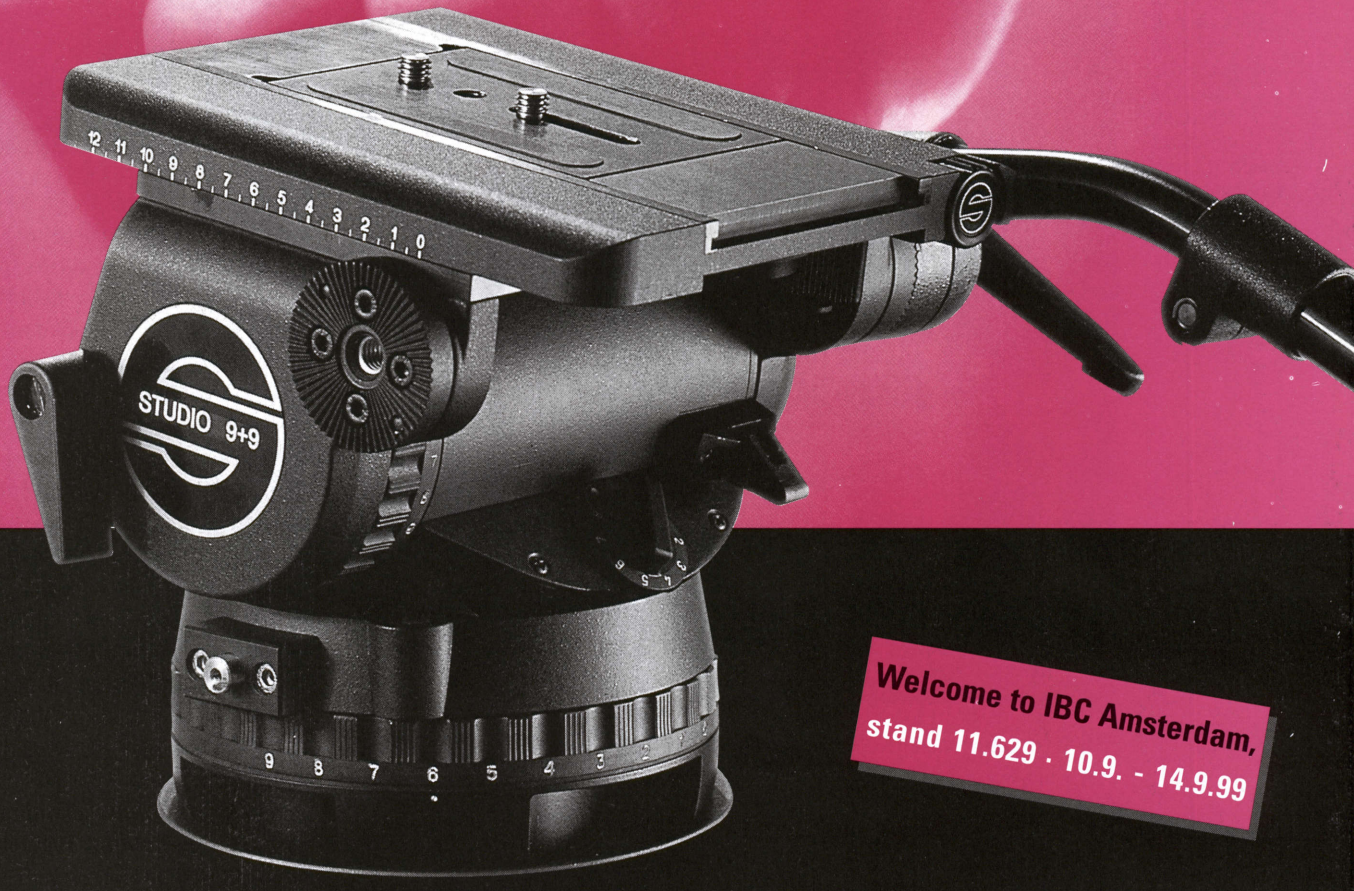

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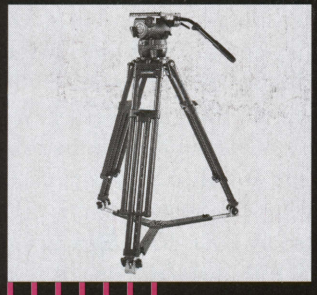

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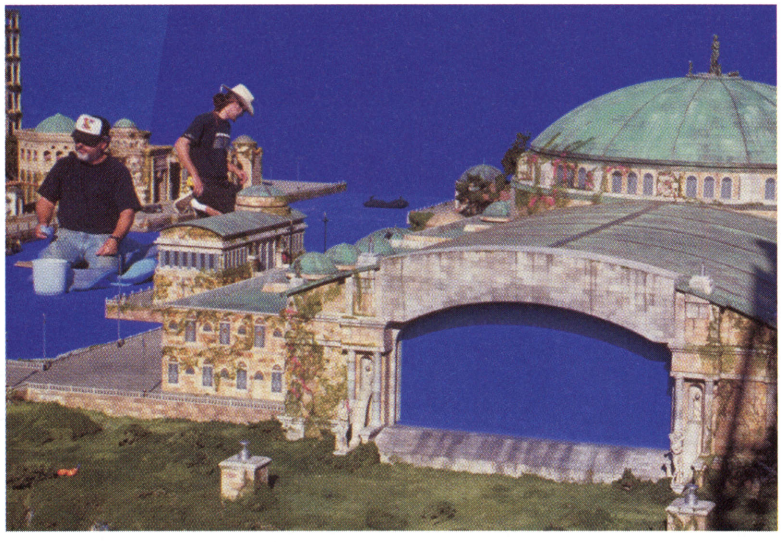
Virtual Realities

Anakin Skywalker takes off from the palace hangar on Theed in his chrome-trimmed yellow starfighter. The waterfall effect was created separately by pouring salt over textured black shapes, and then composited in later. The miniature structures depicting Theed were built to be reconfigured for use in multiple shots.



which exactly matched the partial sets that were built in England for those shots where we extended the sets with the miniatures. We'd get together with Doug Chiang and set up the miniatures to create streets for the courtyard battle or the final parade. We also built smaller versions of some buildings. One of the fortunate things with that style of building is that it was hard to tell an exact scale, so a domed building could be played as 12' or 50' tall, depending upon what was next to it."

Squires' first shot involved the Gungan submarine rising out of the water. Although his team was working with the same digital sub model used by Muren, dealing with the vehicle in exterior sunlight presented special problems, forcing Squires' artists to change their approach in creating the sub's bubble-film cockpit cover. Even more difficult, however, was integrating the original live-action plates of the actors on a practical sub mockup with the miniature backgrounds. "Some of the submarine shots were filmed at different times of the day in England, so we'd have shots of the sub in overcast conditions and hot sunny light cut in side by side," Squires sighs. "In order to make sure all of that matched, we shot the miniature Theed buildings in sunlight and in shadow, and then the matte painter cut a matte that split a shadow line, as if it was broken up by dappled lighting. We then combined those two passes to create the right dappled effect that would match the lighting in the original plate."

Matte painter Brian Flora created a half-dozen views of the Queen's Palace — a Maxfield Parrish dreamscape perched high atop a cliff with cascading waterfalls — using a variety of digital and photographic techniques. Flora relates, "It's important, especially when you're creating something with a lot of intricate detail, to start with either a practical miniature or a CG model that you can throw some light on. It's helpful to have a frame of reference so you can convey all the nuances of light hitting delicate shapes. To facilitate that, I started with a polygonal CG model of the palace created by CG artist Louis Katz.

"For the first palace shot, where you see the architecture on top of these cliffs and the waterfalls cascading down the sides, I built a quick and dirty practical model out of foam and tinfoil, then painting it to look like a lush, tropical wall in Hawaii, per Doug Chiang's art direction. I photographed the model in sunlight and used it in conjunction with the CG model of the palace created by Louis Katz. That was the basis for the matte painting. To create the waterfalls, the guys in the model shop, a team led by Marty Rosenberg, poured salt against a black background and filmed it. When they were done, it looked just like water! I took those elements and

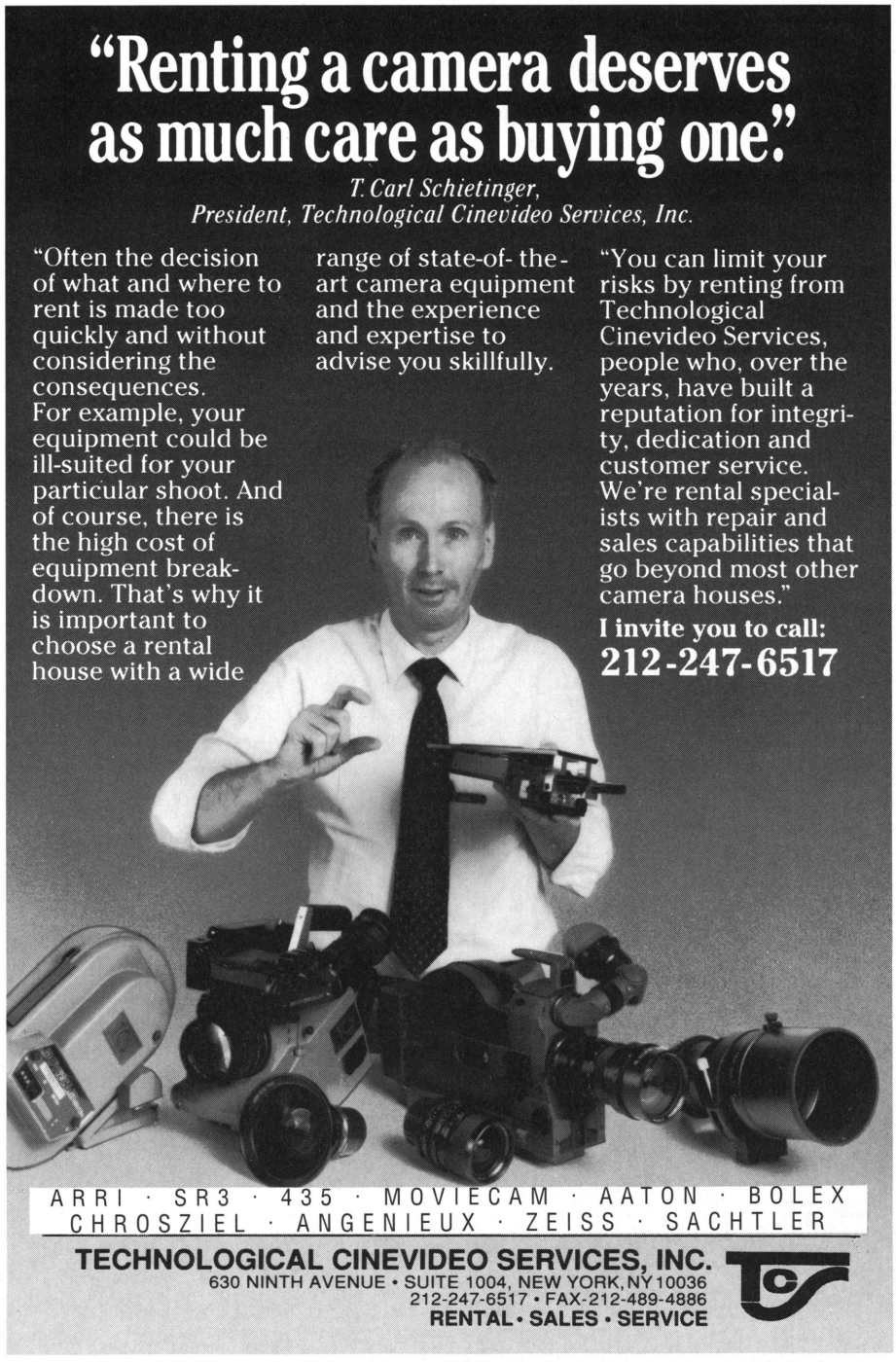
composited them into the shot, adding rocks and painted water highlights to make it appear that the water was interacting with the topology of the cliff face. It was fun putting all of that stuff together — it was like making a little diorama."

Once the matte paintings were complete, Flora used John Knoll's method of projecting the painting over simple shapes to create a convincing 3-D environment with a lot less computer power. "For me, it's almost as if I'm painting detailed, photo-realistic wallpaper to put on shapes," Flora explains. "As long as the wallpaper is good enough, the shapes don't have to be too complex."

On the other hand, the work that Squires' team did inside the Palace throughout the film — particularly during a firefight between Queen Amidala's guards and a group of Battle Droids, and the climactic lightsaber duel between the Jedi knights and Darth Maul — exemplifies ILM's ability to create environments that could never be constructed in the real world. Not all of these digital set extensions called attention to themselves, however. "Did you notice the interiors when they characters are running down a corridor?" Muren wonders in an incredulous tone. "Well, the ceilings are three times higher than they were [on location at Reggia Palace in Italy], and the corridors go back 500' farther than what was really there. Every shot was like that — one after another after another."

Squires recalls, "One of the issues that came up when they shot at the real palace in Italy was these huge candelabras sticking off the sides of the walls. We removed them from every shot that was real or partially real, and in some cases, we replaced the sculptures there with other things, so the vast majority of the Theed Palace was partially synthetic."

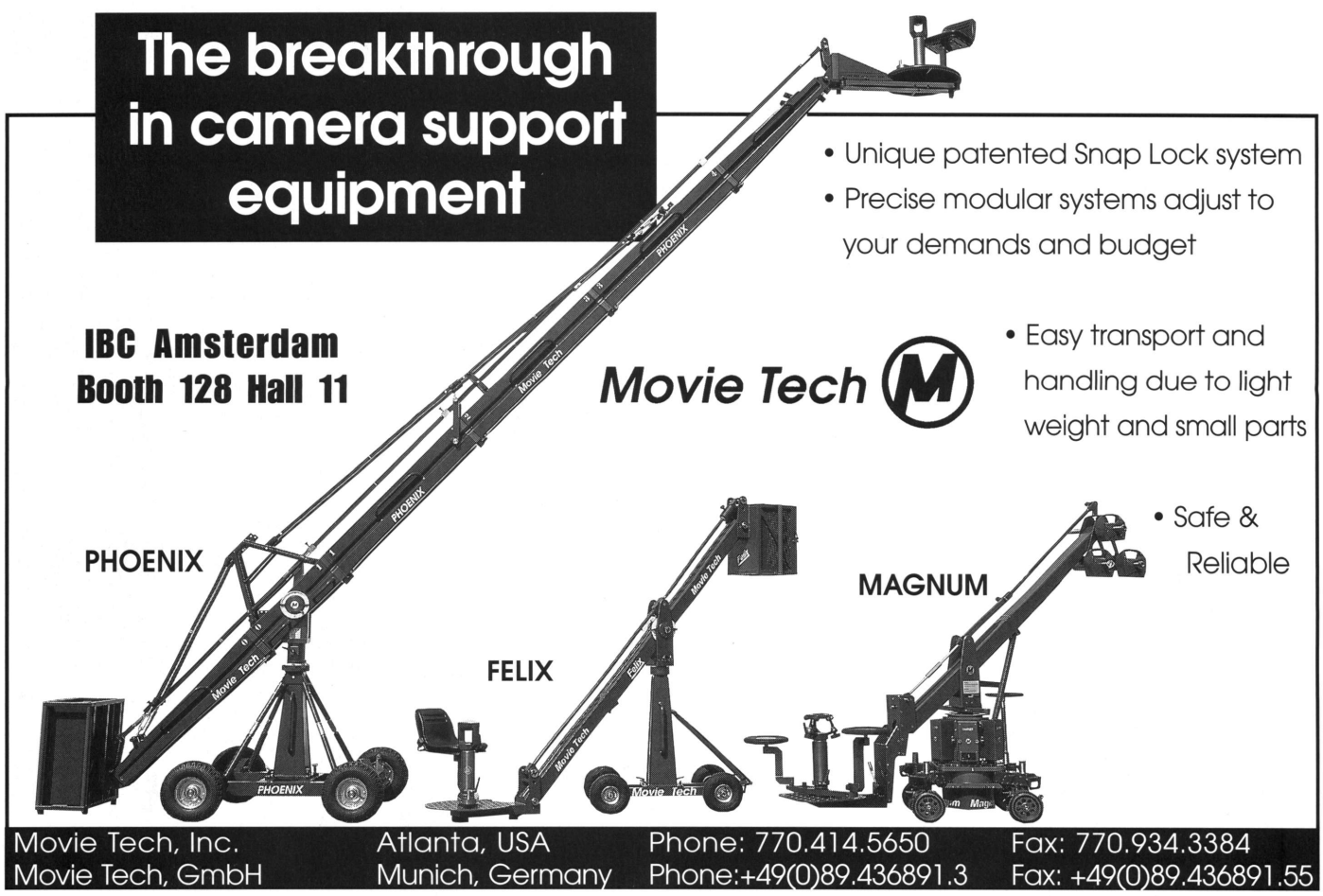
Nowhere was this more apparent than in the climactic lightsaber duel, which pits Qui-Gon and Obi-



Wan against the evil Darth Maul in the Palace's massive generator room. Lucas shot the live action with actors Liam Neeson, Ewan McGregor and Ray Park on partial sets surrounded by bluescreen. The final environment consists of a vast chamber seemingly hundreds of feet high, filled with gigantic vertical glass cylinders measuring 24' across. This chamber is connected by an energy corridor to another room, where a teardrop-shaped walkway spans a steel chasm that seemingly descends forever. Squires recalls, "The energy corridor where Obi-Wan gets trapped was built as a set up to around 15' high, and it was contiguous with the walkway room. The first room had two consoles and some of the floor that went around it. The other room had a piece of the walkway, maybe 20' long by 8' wide, and part of the ring around that, which was surrounded by bluescreen so we could add the chasm around it. That was all they built. Ultimately, though, we had to create a huge environment measuring about 600' across."

Consequently, shooting the action sequence against so much bluescreen created a whole new set of logistical issues. "For example," Squires notes with a chuckle, "when Obi-Wan and Qui-Gon leap across a chasm to the walkway, the top of Liam's head went out of frame, so we had to animate his head back in. When Darth Maul leaps and spins in the air, he actually flew into a blue landing pad, so we had to remove his legs at the impact point — we switched over to CG legs while he was in mid-air until he landed. In another shot of all three guys fighting together, they were all photographed independently and then combined. Also, in order to make the fight more dynamic, we moved them tighter together to make their connections more obvious, as when Darth Maul kicks Obi-Wan a couple of times in the face. Those kicks didn't actually connect, and it was evident in the shot, so we had to split Ewan out from his set, push him over, and do some paintwork shadowing on his face to create the impact of the foot. There are a handful of shots that were done with stunt doubles, so we had to do face replacements. There were also a number of cases where the stunt people were using trampolines or springboards or wires, so those had to be removed as well."

There were further complications once shooting was over. "Most of the sets we later worked on — the Queen's Palace and courtyard, the spacecraft hangar, the hallways, the generator room — were built with just a little bit of headroom up above, which meant not only following the blueprints [created by production designer Gavin Bocquet], but match-



ing what his crew had built," Squires says. "In some cases, there were considerable deviations from the designs or even the blueprints in terms of what ended up on the screen. The Jedi battle sequence was probably one of the least-designed environments ahead of time. Originally, when we were planning the sequence with Doug Chiang and [ILM visual effects art director] David Nakabayashi, we wanted a much more elaborate, particle-type system inside those huge glass tubes blowing out the lens. But after they shot that scene with some super-bright interactive lights, and after we'd finished that sequence, George took a look at it as a whole and said, 'Well, the light spread too much.' Because of that change in look and style, we ended up redoing all of the wide and medium shots and removing those lights from the live action to make it match the new design. We did a number of those scenes two and three times, often rotoscoping the actors out of the walkway when the look wasn't working. If you look at the close-up shots, there's still a lot of light contamination going on."

Ironically, the combatants' respective lightsabers nearly wrought more havoc on the digital backgrounds than they did on the characters. Squires explains, "There were painted aluminum tubes sticking out of the prop lightsabers, and we used them as guides while we rotoscoped the motion-blurred action. That provided a little bit of flicker for the weapons, as well as a slight shimmer to the edges and a glow. However, we ran into problems with aluminum tubes once the actors got into their lightsaber battles towards the end of the production. The guys, especially Ewan and Ray, hit their weapons together so forcefully that the aluminum tubes began bending! That meant that the rod portion of the prop would be sticking out well beyond the lightsaber beam, and possibly even covering some of the set. We had to paint the bent parts out, otherwise, we'd end up with either a bent lightsaber, which would look odd, or a straight, glowing lightsaber with this little metal thing sticking out of its side. Also, in the stunt shots, the actors just had the lightsaber handles or little stubs, which meant that we had to 'guesstimate' where the beams were and how long they should be."

The results of these labors, however, speak for themselves in the finished film. The painstaking diligence of Muren, Knoll and Squires' respective visual effects teams set a new standard of excellence in creating ersatz environments, forever expanding the ability of cinema to take audiences into fantastic new imaginary realms. ■

CG Star Turns

The art of 3-D character animation is pushed to new heights for *The Phantom Menace.*

by Ron Magid

The *Star Wars* universe boasts an impressive array on non-human characters, and *The Phantom Menace* adds greatly to this established menagerie by way of extensive 3-D character animation. These new creations include the loose-limbed Jar Jar Binks; his corpulent Gungan leader, Boss Nass; the winged merchant Watto; and an army of Battle Droids. Indeed, ILM's alien beings for *Episode I* are some of the most convincing characters ever rendered by computer.

Perhaps that's because animation supervisor Rob Coleman literally went back to the drawing board to rethink how such CG performances should be created. "In terms of the acting of the characters, I studied some of the great film performances, and I tried to distill them down through my animator's background," Coleman says. "I tried to look at the subtleties that happen in a human face when someone is thinking, listening or delivering a line, to see how we know when someone's saying one thing but meaning something else. I specifically wanted to make fantasy digital characters have the same kind of life and breadth that humans do, which was daunting."

This attention to the nuances of performance, coupled with an uncanny attention to detail, produced Jar Jar Binks. The bumbling Gungan is the closest animators have come to shaping a totally digital actor, with muscles flexing believably beneath skin that wrinkles, stretches and sags in all the right places. "That started with the modeling department and Geoff Campbell, our senior digital modeling supervisor, who's been at ILM since before *Jurassic Park*," Coleman notes. "Geoff was among the first artists on the ILM computer graphics team to begin building and developing Jar Jar. His crew put lots of effort into giving us control over the muscles of the arms, legs and even the neck. I'm astounded by what they could do in the computer in terms of modeling. After that point, [creature developer supervisor] Tim McLaughlin and his group of what we call 'envelopers' — the people who wrap the skin over a character's

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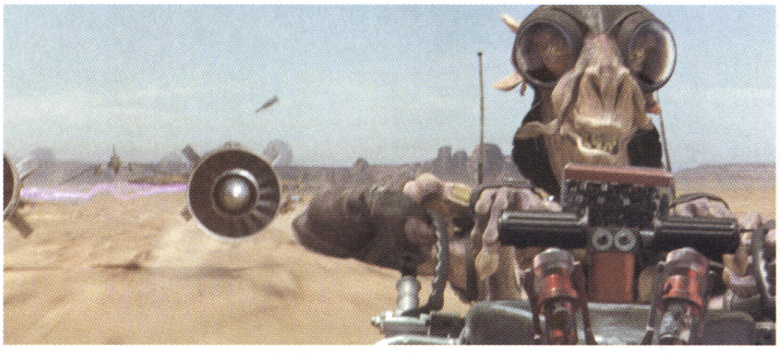


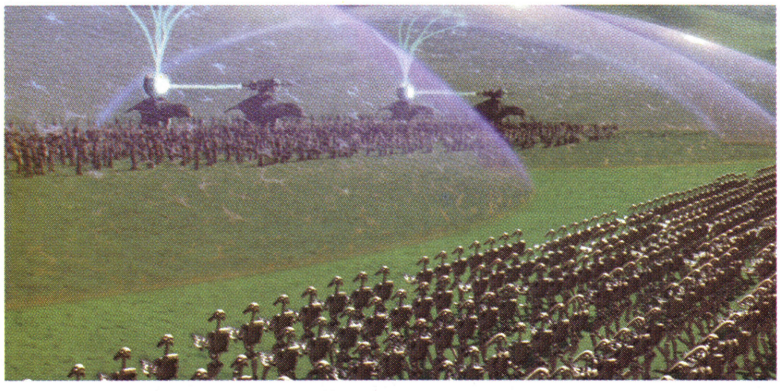
Opposite: Created in Softimage, Watto posed a dilemma for ILM's animators, since his undersized wings, oversized teeth and trunk-like nose worked against using logical, physiology-derived movements and traditional lip-synch techniques. This page: The ill-tempered podracer Sebulba offered other animation challenges, as the character walked on his hands and used his feet for grasping objects and piloting his ship.

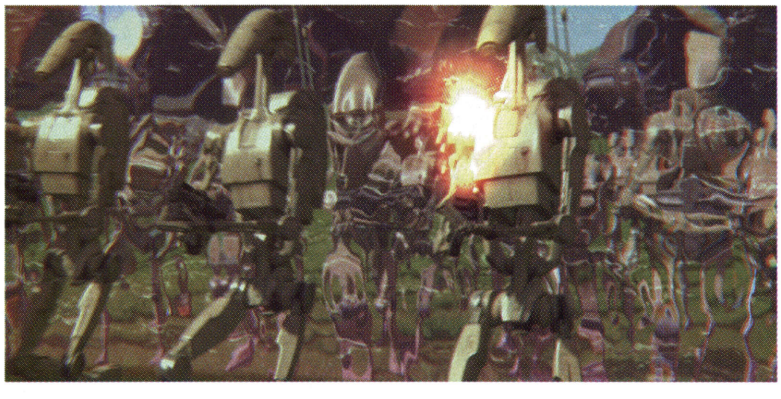
body — got involved. Basically, they looked at each elbow bend or shoulder roll to maintain the volumes of those muscles so that there was some 'jiggle' in the skin. That's the kind of stuff we're used to seeing in human beings, so we miss it if it's not in the computer graphics. We're now at the point where we can actually address those kinds of issues. The clothing simulation that Tim and his group did gave us the ability to shape and control Jar Jar's ears, clothing and muscles, so that we could actually add a level of nuance and realism that you just subconsciously take in. Although the audience is not aware of it, they appreciate the fact that Jar Jar's vest flaps while he runs, and the way his floppy ears lie over his shoulders. Those kinds of subtleties add extra dimensions to the animation, and make the digital characters more real than we've ever been able to make them before."

Further contributing to Jar Jar's believable presence was the wetness of his teeth, which was contrasted with the suppleness of his lips and the shading of his eyes and skin. "Our viewpaint supervisor, Jean Bolte, was expressly interested in how close our characters got to camera, and she and her crew did an excellent job of adding an extra dimension of sophistication to the bump maps, skin textures and shaders on these characters," Coleman testifies. "There was certainly some additional computing power at work, but I think the sophistication of the painting, and the understanding of what makes that skin come alive, is just as important to what you're seeing. Also, on this movie, as opposed to previous films, we had compositing specialists whose job was solely to run their teams of compositors and keep an eye out for the continuity of light and color across a sequence. They really took a good look at the work with their expert eyes, and made sure that there was consistency in the quality of the composites."

Despite the huge amount of 3-D animation necessary to bring fully CG characters like Jar Jar, Boss Nass and Watto to life, ILM's animators relied almost exclusively on hand-animation, as opposed to animation cycles. "Because Jar Jar does lots of walking around, we developed a number of different walks for him, which were cyclical in nature," Coleman reveals. "We made sure that what I called the 'hot-sand walk' on Tatooine was different than his walk through the bushes of Naboo or across a carpet on Coruscant. We tried not to let the cycles show up so

CG Star Turns





Gungan defenders square off against Battle Droid forces on Naboo. Performances by both armies in combat were largely created with libraries of cycled action created via Softimage and Maya (randomly selected by the computer for background action), while key characters and action were specifically animated. The green-hilled backgrounds were composed of still photos taken by Dennis Muren and then Photoshopped together to create a digital backdrop.

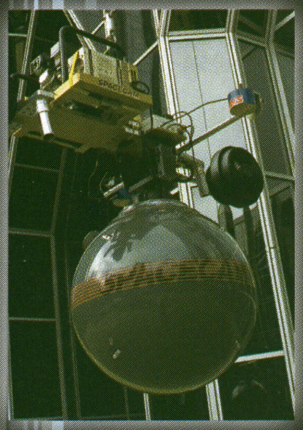
that we could reuse the work from shot to shot. We also did some motion capture for Jar Jar, but it was used only as reference and wasn't actually applied to the character."

While all of the actors who voiced *Episode I*'s CG characters were present on the set to interact vocally with the film's live actors, only Ahmed Best, the actor who played Jar Jar, wore a physical costume: a painted rubber suit and a "duck hat" in the shape of Jar Jar's head. Originally, Coleman and company had hoped they would be able to utilize the detailed suit in some shots, but instead, it ultimately served to provide an excellent lighting reference for ILM's artists. Coleman recalls, "We figured that some of the action would be so complicated that we wouldn't be able to animate it. We thought we'd just do head and neck replacement and use the suit for certain shots. As athletic and amazing as Ahmed's motions were, however, he was just a little too buff for Jar Jar, who's much more slender in the shoulders and neck. If we'd tried to match-cut between the suit and the CG, we were going to have problems. Also, it was no trivial matter to paint out Ahmed's face and then put on Jar Jar's head and neck and get the connections right. Creating interaction with the ears was also extremely difficult. When we did our original tests, we realized that it was easier to remove Ahmed and do a fully digital character. There are no head replacements in the movie, but there are about five shots in the movie with the suit, In one, Jar Jar's hand picks up a screwdriver, and in another, his feet are shown resting on a table while he's sleeping."

Although Best was on the set during to make things easier for the other actors during rehearsals (which were photographed), he would deliver his lines from behind the camera during actual takes. Consequently, creating the physical interaction between nonexistent characters like Jar Jar and his onscreen costars provide quite challenging, especially since ILM only wanted to remove Best from shots as a last resort.

One particularly tricky scene set in the forest of the planet Naboo featured Jedi master Qui-Gon Jinn (Liam Neeson) tackling Jar Jar to the ground in order to prevent a tank-like troop carrier from mowing him down. Fortunately, Neeson was able to pantomime the wrestling action well enough without Best's presence, allowing Coleman's animators to simply add Binks grappling with the actor — rather than painting Best out and *then* adding the clumsy alien into the scene.

For other scenes, the on-set effects crew rigged rods to animate props that would later wind up in Jar Jar's hands, or used thin Mylar fishing line to topple objects as if Binks had bumped into them. As an example, Coleman cites a scene in Watto's shop where Qui-Gon grabs a device out of Jar Jar's hands. "The real device was floating in the air so that Liam could grab it, and then we lined up Jar Jar's CG hands with the object and did a typical rod removal," he



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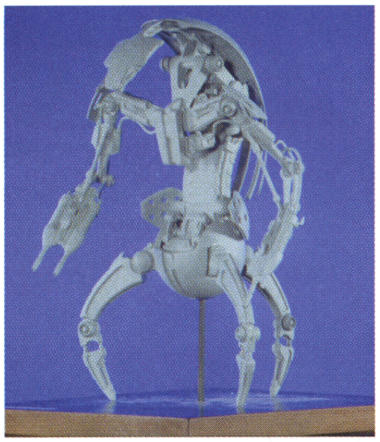
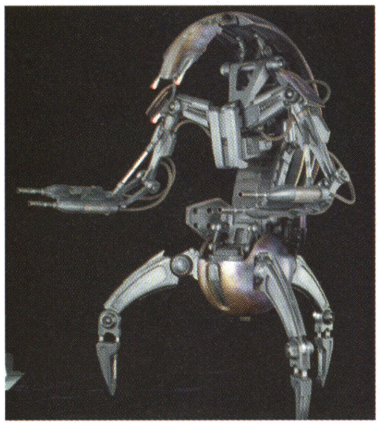
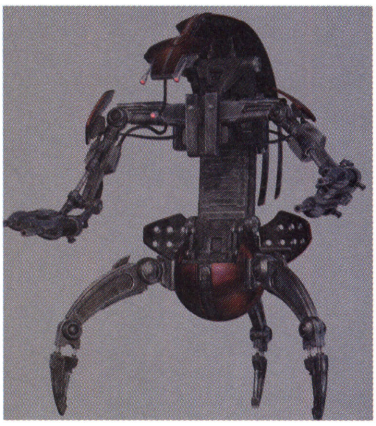
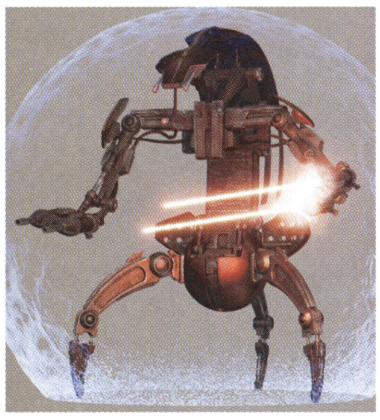
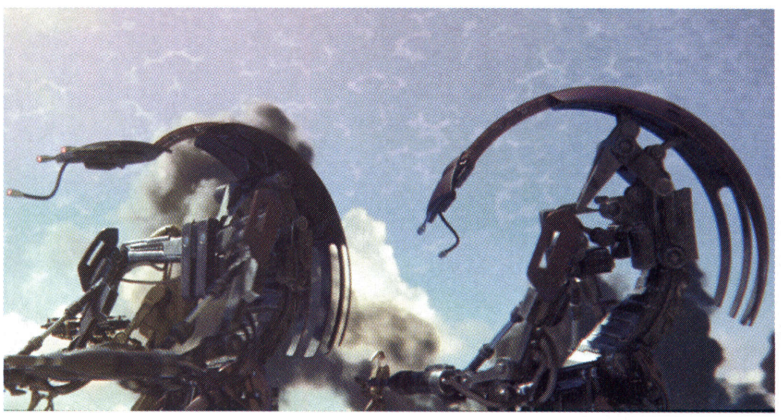










Seen here in maquette and digital form, the complex mechanics of the Destroyer Droids made animating them particularly troublesome — especially their unusual walk cycles. Animation supervisor Rob Coleman studied the movements of hermit crabs, scorpions and spiders in order to develop a proper walk for the deadly devices.

explains. "However, for a later scene in which Qui-Gon grabs Jar Jar's [frog-like] tongue at the dinner table, Liam actually pantomimed the action. Kevin Martel had to animate the tongue very precisely to Liam's fingertips so it looked as if he was holding it.

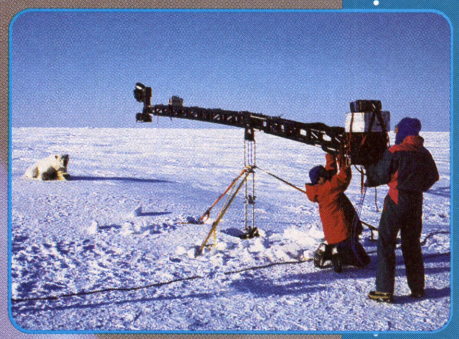
"Our biggest challenge on-set," Coleman says, "was coaching the actors so that their eyelines were always correct after we removed Ahmed. The performers did a fabulous job, but there were several times in the movie when George [Lucas] actually liked the actor's performance in the rehearsal better than the take. In those cases, our poor rotoscoping crew had to paint Ahmed out of the scene, after which we'd put Jar Jar into the scene. Those were very laborious shots."

Even more difficult were shots featuring Watto, the flying alien trader, voiced by Andrew Secombe. "The eyelines weren't correct in the rehearsals," Coleman recalls. "Andy's quite a short guy compared to Liam, so when we did the take, we reminded Liam to keep his eyes up as he imagined Watto hovering in front of him. We had a half-scale maquette that we hung up as a color/lighting reference, which helped the actors visualize Watto, but we took that out of the scene during shooting because we always wanted to composite the digital character over a clean plate."

One of Coleman's favorite characters, Watto was the first to be animated. "We started him in September of '97 and finished him by May of '98, so he'd been done for a year," Coleman relates. "He's a fabulous character. He's has this gruff, grumpy personality, but he also has a bit of a soft spot for Anakin, and that leapt right off the page. When I heard Andy's voice for Watto, I fell in love with it right away. The challenge was to make it feel as if that voice was coming out of that face. We experimented with having Watto talk out of one side of his mouth and squint an eye, and we made him a bit stiff because he's an older creature, with this big belly hanging underneath him as he flies around. He's just a really rich character."

Watto's body was animated using Softimage, with cycles employed only for the beating of his ridiculously small wings. His heavy, dangling nose added some wonderful dynamics to his character, but presented another delicate job for ILM's animators, who used the Caricature facial-animation software developed for *Dragonheart* (see *AC* June '96) to animate their CG characters' facial expressions. Dubbed Cari for short, the software employs a series of models of each character's face, which are blended to create the facial animation. It worked great for characters with fairly tight skin, but in order to bring the bulbous Watto (and later, the jowly Boss Nass) to

It's a matter of STRENGTH



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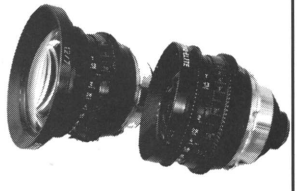

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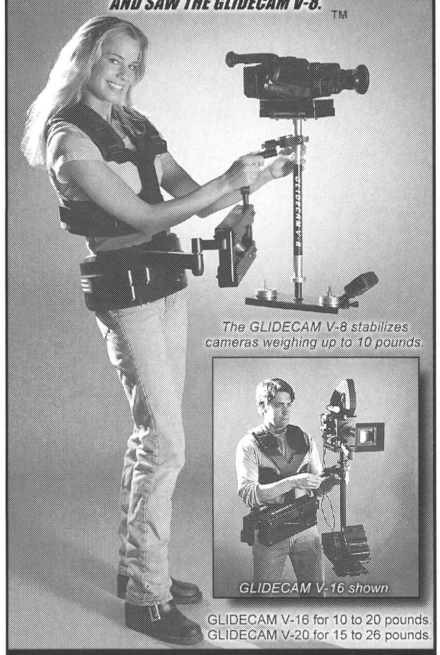

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life, ILM's R&D software team had to make some changes to the program. "Computers have always been really good at doing hard-body things, but I wanted to get an extra level of control over the soft tissues of the face, which we were only starting to figure in during *Dragonheart*," says Coleman, who also was a lead animator on that picture. "I worked very closely with the modeling department, who created a wonderful shape library for us on this film. Cari works hand-in-hand with our modeling software; it's actually one button-click away. If we don't have the particular eye wrinkle that we want, we can make it in probably 15 minutes, and then share it with the other animators and make it part of the library. In the past, we had, say, four different kinds of eyeblinks for *Dragonheart*, but now we may have 25 different kinds for Watto. Also, we can address just the upper lip or the left cheek, and we won't lose any of the essence of the face that we've achieved. As a result of those advances, we ended up with more than 400 different shapes just for Jar Jar's face. That was the kind of progress I wanted to see when I took this movie on. Cari has become even more sophisticated in terms of the fine level of control that we have over things like lip curls or the way a nose swings or nostrils flair. We have a much better understanding of the physiology of characters now."

This better understanding really paid off while ILM's team was animating the flabby face of the Gungan leader, Boss Nass, a CG character who, thanks to voice actor Brian Blessed, developed a habit of shaking his jowls. "That's taken almost frame-by-frame from Brian, who came up with the idea during rehearsal. George loved it so much that we just put it right into the character, almost verbatim," Coleman says. "I've got wonderful video footage of Brian doing that same action, which we studied frame-by-frame to see exactly what happened to his face. Back at ILM, we began building shapes to replicate that. It took several days to figure everything out, but, once we did, we had control of that nice, loose skin, which is what we were trying to achieve. While I'm certainly proud of what we did on this movie, I think that we should continue to work on creating that kind of soft, organic feeling."

None of that was necessary, of course, for the legions of droids that Coleman's animators unleashed in *Episode I*. These fearsome units including the flying Fighter Droids, hordes of Battle Droids, and perhaps most sinister of all, the rolling Destroyer Droids, which have an uncanny knack for popping up when the film's heroes least expect them. "Those came out of the imaginations of [art director] Doug Chiang and his amazing illustrators up at Skywalker Ranch,'" Coleman enthuses. "Once they stop rolling, they pop up on three legs. Well, Mother Nature gave us two legs and four legs for a reason: three legs are very hard to work with! If, say, a camera tripod were able to lift one of its legs, it would immediately fall over. Because of that, I studied things how hermit crabs, scorpions and spiders move around; even though they've got multiple legs, they have the same kind of leg structure as the Destroyers. It took us a while to come up with a walk cycle that would make it look as if they were actually being motivated by their own limbs."

The Destroyers are immediately threatening by virtue of the sinister way in which they roll into shots. "I think that comes from the camera angles we chose, and the fact that they bank into the corners like motorcycles do," Coleman opines. "They've also got this amazing metal-on-metal look and ominous colors, plus all of that spinning interior stuff, which is fascinating to the human eye. Their speed, their weight and the way that we stopped them

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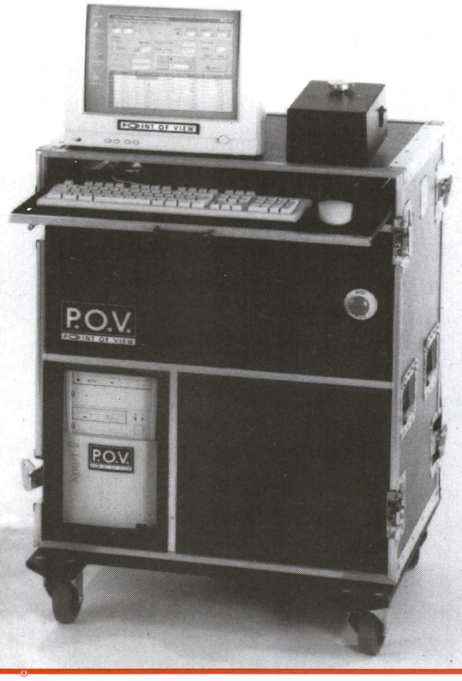

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also added some menace. They actually overshoot their mark, plant their two front legs into the ground, and then pop up. We got the inspiration for that from wolf spiders, which dig their legs in when they lunge out of their holes. We also layered different motions on top of that to achieve a visceral feeling — like the compression of their guns and the swinging of their pneumatic hoses, which we accomplished with our proprietary simulation software. As a final touch, we added an overall shake going through their bodies as their heads spin around. We were really inspired by their design."

While the organic CG characters were almost exclusively hand-animated, the legions of Battle Droids, marching in mechanical lock-step, lent themselves to that time-saving animation technique of cycles. Still it took some finesse to prevent discerning viewers from noticing the cycles' telltale repetition. "The firing of the Destroyers' guns was a 200-frame cycle, but the shots were probably not more than 75 frames, so the cycle never actually repeated," Coleman observes. "For the Battle Droids marching in formation, we used four different march cycles that were offset, so they're not exactly lock-step. We then used an algorithm to add some extra head actions, so there's some randomness to them."

The climactic land battle on Naboo, in which 5,000 Gungans square off against 5,000 Battle Droids on the lush green battlefield, presented another epic task. The only way to get all of those shots in the can was via animated repetition. "There's a lot of cloning going on instead of performances, so we could get it done," admits ILM's senior visual effects supervisor, Dennis Muren, ASC, who oversaw the sequence like a five-star general, working closely with ground battle animation supervisor Tom Bertino. "We didn't have the time, crew or money to hand-

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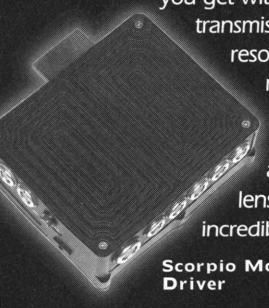

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animate every Gungan or Droid, and I don't know if anyone would really want to. Instead, we picked out the 'stars' in each shot, who were custom-animated; those individual characters are really what we were primarily looking at. They may not be in the foreground, but they're doing something different from the rest the characters in the shot, so you don't get a sense of seeing repeated actions. We put a few stop-motion animators on the computer, so if you look into the backgrounds, you'll see a few Ray Harryhausen-like performances. We tried to use as many characters as we could over again, because there were so many, and they were always offset. We had maybe eight or 10 Droids that got hit in different ways and fell down, and we had just a very few walks that we would use. For the background of the battle, we pulled Droid and Gungan performances from these libraries we'd made that were filled with much longer takes than you'd ever see onscreen. We could pick 100 frames out of a 400-frame animation, which we could view from any angle we wanted. We'd then clone that animation, mirror-image it and apply it to 100 characters."

Motion capture was also used to animate the thousands of combatants in the ground battle, among other sequences. "When I first saw the script and realized how much work there was, I was overwhelmed at the screen time that we had to produce," Coleman admits. "Since we've got a crack motion-capture crew here, I decided to look into what they could do for us. They convinced me that they could handle several hundred shots, and I think there are some 230 shots that have motion-capture elements in them. For example, a lot of the hand-to-hand stuff between the Gunguns and the Droids in the ground battle was a combination of animation and motion capture, and a lot of the Battle Droids that you see elsewhere in the film were also motion captures."

Amazingly, due to some big improvements in ILM's rendering pipeline, Muren was able to fill the ranks of the Droid and Gungan armies with original rendered animation — as opposed to rendering just a few characters and then comping them over and over again to fill out the shots. "We were going to try that as a backup approach, but we didn't need to," Muren states proudly. "The guys came up with this great, fast way to actually animate and render all of those characters. Fortunately, we were always pretty much panning or tilting on the background, which was mostly made up of tiled still images, so it wasn't rendered. We didn't reuse elements

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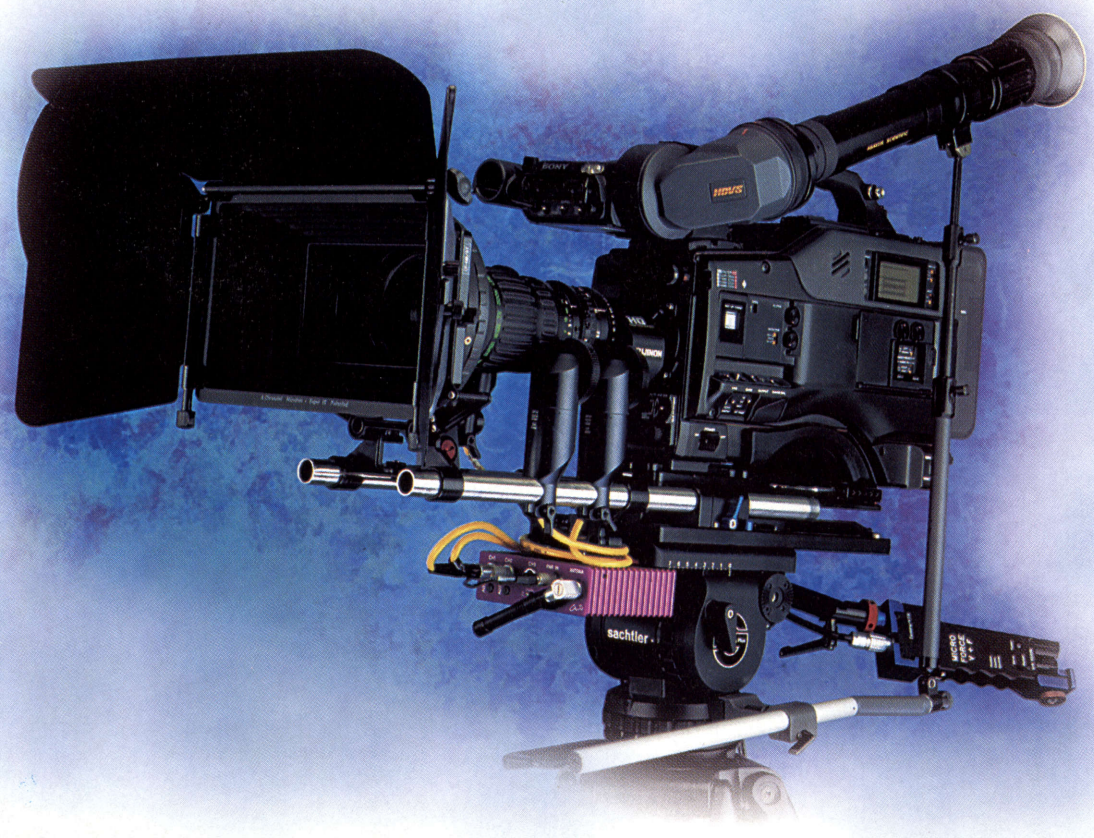
very often — if at all."

The green hills of Naboo that form the background for the ground battle were largely made up of hundreds of locked-off images. Muren recalls, "I went to central California and shot probably 200 or 300 stills over a couple of days, and then [digital matte artist] Ronn Brown Photoshopped them together so we could make moves. In most of the shots, we were really just panning around on stills, but we needed about 12 background plates where the camera was moving along. We shot those up in Petaluma. George wanted the landscape to start out as pristine and beautiful, but to show that by the end of the battle, the Droid army has just raped the environment. Ronn painted the grass and everything, then positioned the explosions and added smoke and fire elements so the shots looked really neat."

Perhaps the most unnerving moment of the ground battle occurs before the actual conflict, when the doors of the massive locomotive-like MTT troop transports open and reveal thousands of Battle Droids hanging on racks, waiting to be activated for combat. The sequence is so visually startling that the horror is also perversely beautiful. "When we first saw the animatics for that sequence, we had the same feeling," Muren agrees. "It was like, 'Wow! This is a great shot!' That shot cost a lot of money, man. All of those Droids had to hang correctly and move around correctly. You know how they're kind of wobbling when they come out? When we first did the shot, they were stiff, and you would have thought they were part of the ship. We came up with the idea of making them sort of sway like they're hanging, so when they come out and you see these 200 separate Droids on the ground, you get the idea that this is how they're delivered."

Muren's crew spent some eight months working on the ground-battle sequence. "I had a great bunch of people working on that stuff, because it was difficult," Muren concludes. "And George just let us go with it — there were no restrictions. It was terrific."

As impressive as *Episode I*'s character animation is, ILM's artists are already gearing up to make the CG inhabitants of *Episode II* and *III* even more realistic. "I guarantee it," Coleman promises. "You've seen Version 1.0 in this film, and I'm already working on Version 2.0! We're going to be using the kind of bone-and-skin technology that they came up with for *The Mummy* [see *AC* Aug. '99]. We're really only scratching the surface of that right now, but I think it's going to add an extra level of realism to the characters in the next movie." ■



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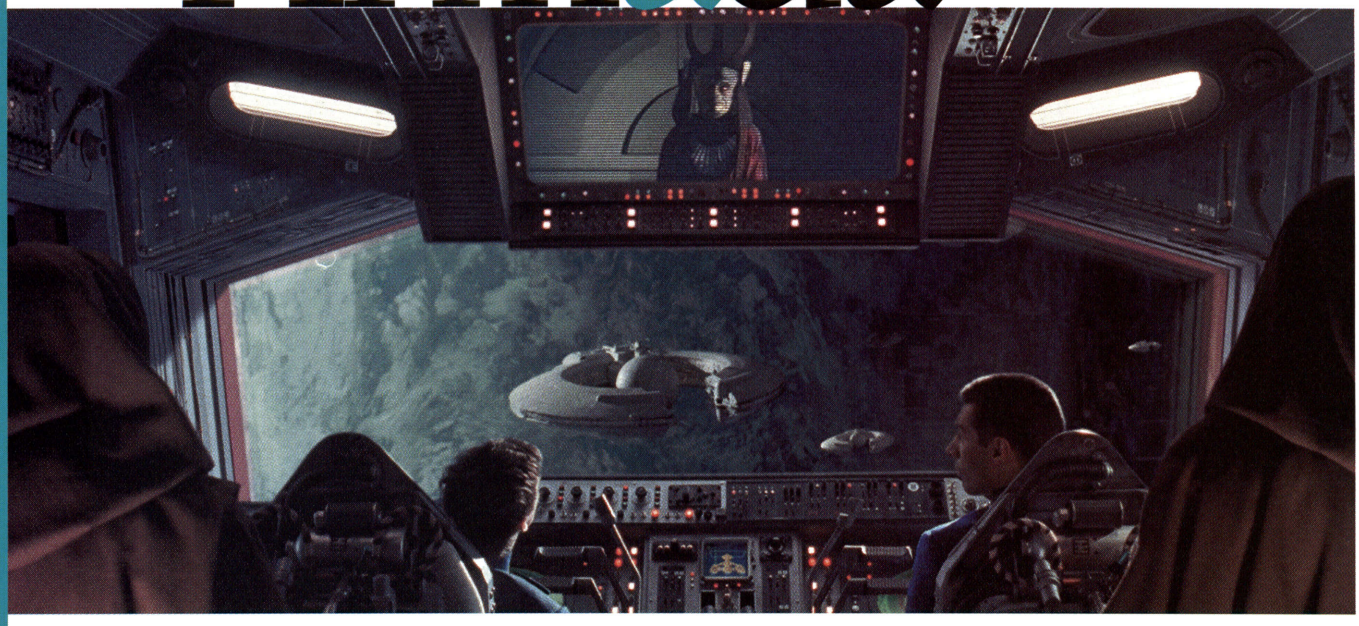

A fleet of CG models and traditional miniatures take flight across the *Phantom Menace* universe.

by Ron Magid

The design and execution of the spacecraft and other vehicles of *The Phantom Menace* defy expectations. In a bold move, director George Lucas chose to eschew the original trilogy's heavy-metal design — visualized by conceptual artist Ralph McQuarrie and subsequently expanded by other talents — and move toward a more streamlined aesthetic, in terms of both design and performance.

Lucas asked art director Doug Chiang to give form to the hardware utilized by the film's forces of good and evil, and subsequently handed the formidable task of creating virtually all of *Episode I*'s space effects to visual effects supervisor John Knoll. Both men had worked on the *Star Wars* Special Editions; Chiang designed the planet-city of Coruscant, while Knoll re-created or enhanced the numerous space battles.

Chiang's first impetus was to give Lucas designs that were inspired by what was seen in the original trilogy, but the director's reaction surprised and encouraged him. Chiang recalls, "George said, 'Let's push the envelope a little bit further. Let's explore different looks and textures. Let's try art nouveau. Let's try chrome.' I was really excited to hear that, because it reinforced the idea that George wanted to dazzle people with a wholly original style, and yet still fit within established *Star Wars* conventions. At first, we weren't quite sure how that would work, because we were going to depart so far from the original look. It actually worked out really well, because we began relating our concepts to the history of industrial design in the U.S. We equated *Episode I* to the early 1900s, when industrial design and art were very much intertwined. Everything was beautifully designed and had a more handcrafted look. Fitting into that timeline worked out well, because as we progressed to the period shown in *Episode IV* [*A New Hope*], the assembly-line aesthetics began taking over and things started to look a bit more manufactured. Using that kind of timeline really worked as a design philosophy, because those changes actually occurred in [American] history; it guided us and gave our design structure a really strong foundation."

Rather than focusing on any one aspect of design, Chiang chose to work concurrently on *Phantom*'s environments and spacecraft. "That way, all of the forms were more homogenous and beautiful," Chiang opines. "George wanted a world that was very romantic, in which the defining aesthetics of good and evil weren't quite established yet. That allowed us to get away with designing

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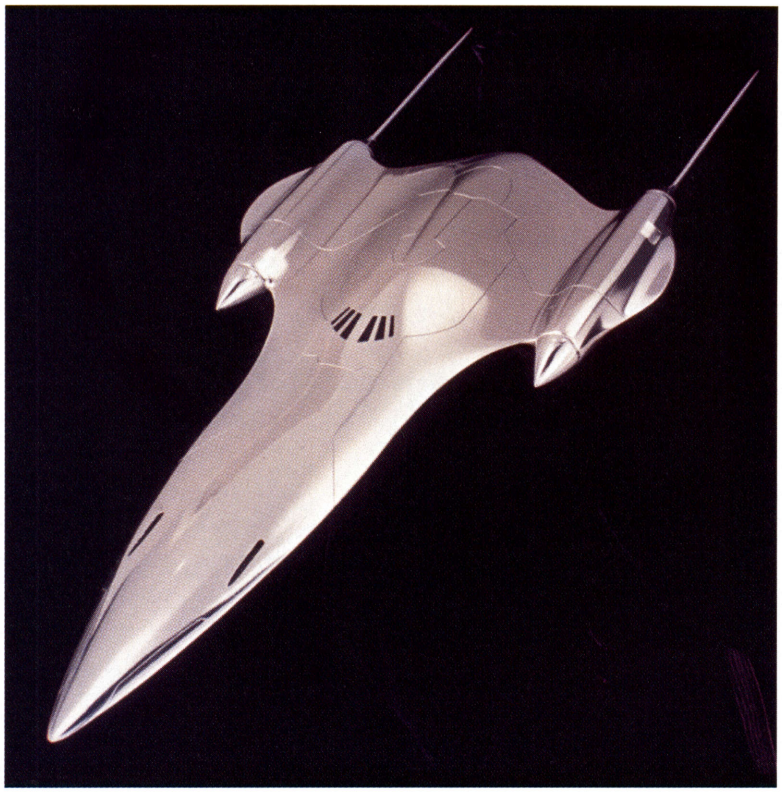
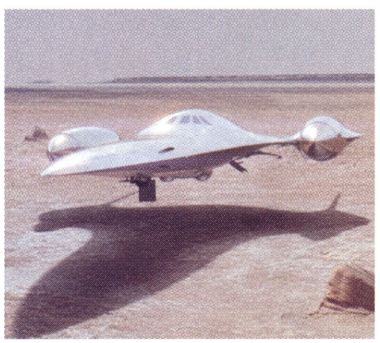
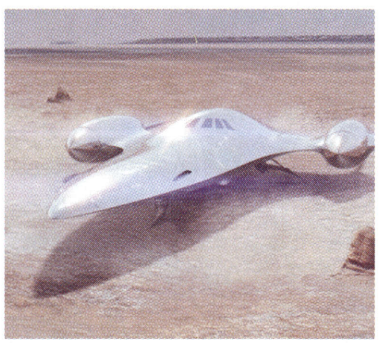
elegant pieces of machinery. As we progress to *Episode II* and then *III*, we'll see the designs segue toward the look of the original trilogy."

That said, Chiang notes that the first finalized *Phantom* designs were the spacecraft and battle tanks, which were more in line with the visual style of the original trilogy. Lucas and Chiang decided that the dark side of *Episode I* would be represented by certain animalistic shapes: lions, elephants, even dragonflies. "A good example of that concept is the Trade Federation Landing Ship with the two large wings, which looks like a biplane hovering over Naboo," Chiang says. "Those double wings were inspired by ancient dragonflies, amazing creatures that had 4' wingspans. The early generations of that design were more like giant, slow-moving dirigibles that would moor onto the planet and deposit the troops. George was lukewarm to that idea, because he thought it wasn't aggressive enough for the Droid Army. In trying to create a personality for the landing ship, I began looking at primordial-insect references, and found some ancient dragonflies. I literally did a mechanical version of those, and as we refined the look, the long tail got lost and all we were left with were the two wings."

In fact, animals inspired all of the Droid Army vehicles. "They were supposed to be aggressive forms," Chiang explains, especially during the climactic ground battle on Naboo. "We tried to give the Droid Army this very animal-like personality. If you look at the Attack Tank from the front, it suggests a pouncing lion, while the MTTs, the big transports that carry the troops, have elephantine shapes, so you know that they're fearsome machines as opposed to peaceful vehicles. George described the MTT as a floating locomotive that could plow through anything. When he said that, certain images came to my mind; one of the first was a charging bull elephant. My







SPACECRAFT DESIGNS

Opposite: Via viewscreen, the Neimoidian viceroy welcomes a Republic cruiser carrying Jedi emissaries to dock on their Trade Federation Battleship as it orbits Naboo. The spacecraft was constructed as an 8'-diameter miniature in order to achieve the detail necessary to suggest its immense size This page: The Queen's Ship touches down on Tatooine. While the sleek spacecraft was principally used in the form of a CG model, a 10' miniature was constructed for shots in which it was stationary.

first designs, which included structures that emulated elephant ears and tusks, were perhaps a bit more literal, but everything merged into the final design. The elephant forms are subtle, but the front was modeled like part of the trunk, and the two big side bulges that terminate in guns are like the tusks."

The viewer's first glimpse of the MTT Troop Transports is an impressive low-angle shot executed by the ground battle's visual effects supervisor, Dennis Muren, ASC, who revised the original previsualization animatics by David Dozoretz and his crew at Skywalker Ranch. "That had been designed originally as a high shot, 50' to 70' in the air looking down upon the vehicles as they came over this hill," Muren recalls. "I looked at it and said, 'The transports are way off in the distance, and you don't get any idea of how big they are!' I felt we should do a low-angle shot to make them look bigger. At the beginning of the shot, we'd already have these two tanks in frame, and I wanted to see other, larger things come in from the side during the shot, so the shot would grow into something even bigger."

The signature spacecraft of *Episode I* is the Queen's Ship, which takes Amidala, her entourage of courtiers, and her Jedi protectors

A New-Age Armada

A fierce battle rages over the Federation command ship. Much of the background dogfight action was created using libraries of action involving Naboo starfighters and Federation droid ships, while pyrotechnics were drawn from a vast collection of generic blast effects.

from Naboo to Tatooine and Coruscant and back again. The design did not come easily. "We pursued the Queen's Ship for quite a while," Chiang confesses. "George wanted something very unique, a piece of machinery that was the highlight of Naboo's technology, and epitomized Queen Amidala's power and status. George wanted to contrast Naboo's old-world architecture with sleek chrome. He equated the Queen's Ship to chrome hood ornaments, which was actually a very intriguing design direction to go in. Chrome makes an incredible statement and is beautiful visually, which fit in with our design philosophy for Naboo — all of the things on the planet were more like works of art, designed less for function than for beauty. Some of the first designs for the Queen's Ship were literally like chrome rocketships from old movies from the 1950s and '60s — very sleek, with fins and so forth — but most of those didn't have enough personality for George. Finally, I started looking at our best modern-day aircraft. I've always been very fond of the '70s-era SR-71 Blackbird spy plane. It's an old design, but it was cutting-edge at that time, and it's still one of the most visually appealing. George liked it, too, so it seemed fitting that merging the SR-71 with a chrome hood ornament would be the ideal solution. We then added the long spikes on the wingtips — more for style than function — to give it that art-form look. We didn't want to explain how the Queen's Ship was made, but we wanted audiences to understand, just by looking at it, that Naboo has some very unusual and exotic technology in order to hand-form and hand-polish these very smooth, seamless ships. Once we massaged the design, we built a prototype maquette and then refined the proportions."

The maquette itself was chromed, and visual effects supervisor John Knoll photographed it extensively to create a reference for the CG model. Although mirrorlike objects have been a staple of computer graphics since *Terminator 2*, the Queen's Ship posed some unusual problems. "We wanted to make the chrome surface a little more sophisticated, not just 100-percent reflective," Knoll explains. "We noticed things in the pictures of the maquette that we went to great pains to duplicate in CG, including tiny scratches in the chrome that created little rainbow diffraction patterns. We did some additional rendering passes to add bits of dirt and the purple and brown stains around the engines where the chrome had heated up and slightly discolored. We also wanted to see the unfolding landing gear reflected in the underside of the ship, which we accomplished with a ray tracer. Because the ship was so reflective, we needed to create a 360-degree environment so it could reflect things that were behind the camera as well."

While any shots depicting the Queen's Ship taking off, landing or flying used an entirely digital model, Knoll had a 10' model built for scenes in which it's parked in the Tatooine desert or on Coruscant. "That let me shift about two dozen shots from being big 3-D shots —where we had to set the ship up, light it and get the reflections right — to simple 2-D stuff. We could just take a photograph of the model and work it into the plate in 2-D."

Knoll and company also spent nine months creating the 100-plus shots that comprise the epic space battle that rages over Naboo. "I wanted to do that sequence because I knew it would be fun to do a *Star Wars* space battle," Knoll confesses.

Thanks to Knoll's team, virtually the only things flying through space in *Phantom* are pixels. Lucas wanted the climactic space-battle sequence to prove that digital models could have as much depth and detail as their physical counterparts. "Since people are seeing a lot of space battles on TV every week, we felt it was necessary to take things to the next

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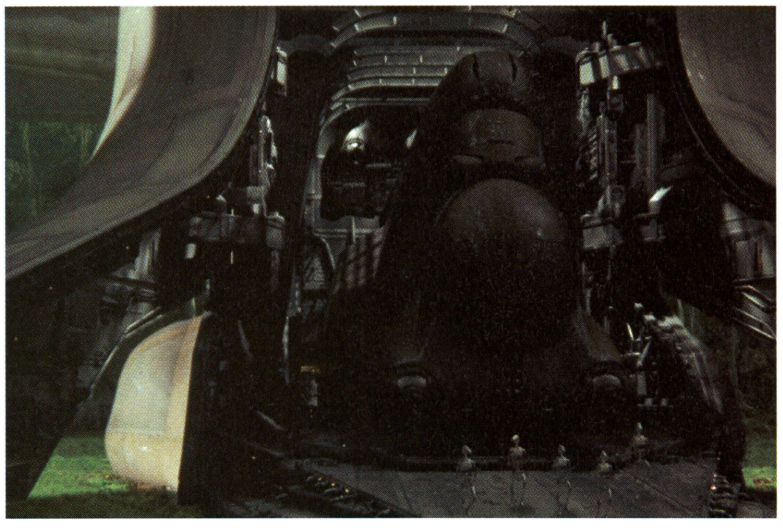

An elephantine MTT transport departs from its landing craft. The motorized miniature could roll down the ramp on its own, while the action would be picked up later in other shots. Recalls designer Doug Chaing, "My first designs, which included structures that emulated elephant ears and tusks, were perhaps a bit more literal, but everything merged into the final design. The elephant forms are subtle, but the front was modeled like part of the trunk, and the two big side bulges that terminate in guns are like the tusks."

level, with a lot of attention to detail," Knoll states. "Therefore, many of our space scenes were pretty dense, with lots of ships flying around, and we were always trying to put in those last little details that are sometimes skipped. When the Naboo starfighters fired a laser, we made sure to have interactive laser light reflected in the chrome and on the ships around them, and when they flew by another ship, we made sure they cast the right shadows."

Working with Chiang, Lucas developed two opposing spacecraft designs — the sleek Naboo starfighters and the hulking Federation Fighter Droids — and then pitted squadrons of them against each other in a duel to the death. Chiang explains, "Since these spacecraft were going be in a battle where things would be moving very fast, George wanted shapes that were very unique, so the audience could instantly differentiate a Naboo starfighter from a Fighter Droid."

Chiang's designs recall the classic designs of the original trilogy. The chrome-and-yellow Naboo starfighters combine aspects of the Rebel X- and Y-Wings with *Episode I*'s signature art nouveau influences. "It's a variation of the X-Wing," Chiang admits, "but we simplified it into a piece of jewelry. The inspiration for the tapered spikes [located at the end of the fuselage and engines] was an art nouveau hairpin with a long, tapered needle that we found in a reference book. The hairpin was such a beautiful shape, I could see right away that we'd have a beautiful spaceship."

Meanwhile, the Federation Fighter Droids reprised the classic "H" silhouette of the Imperial TIE fighters seen in the original *Star Wars* trilogy, but offered some other nifty features as well. In fact, the ships were designed as robots that folded up into spacecraft. "Originally, the Battle Droids were going to be piloting saucer-shaped spaceships in the final space battle, and George had approved that design," Chiang relates. "But he later realized, 'Why do Droids need to pilot spaceships? Why can't the spaceships themselves be Droids?' It was wonderful imagery, because the whole idea of transformation was beautiful. I then took stylistic elements from the Battle Droids and combined them with a TIE fighter when the Fighter Droid folds up into its spaceship configuration. When I backed that out, and basically unfolded the creature to see how it would walk, something very special happened: it began to look like a pterodactyl in the way its limbs were positioned. It was a wonderful combination of ideas that wouldn't have happened if George hadn't expressed that desire."

To spare the animators, Knoll's unit employed some traditional miniatures for the climactic space battle. "We built an 8' motion-control model of the big Federation Battleship, which would have been a really complex CG model to build because it's got a lot of detail," he explains. "Many of the shots that we'd planned were scraping along its surface, so we would have had to build it with a high level of both geometric and textural detail. I just thought it would be an overall bigger bang for the buck to build a miniature and shoot it. We also built a 4' Naboo starfighter that we blew up. There's still a lot to be said for building a model and blowing it up!"

Years ago, this writer asked Dennis Muren, who was then completing *Jurassic Park*, what effect he'd most like to see in the new world of computer graphics. Muren said he'd really like to blow up an X-Wing in CG, and plot the dynamics of its motion. As the years went by, that dream seemed no closer to being realized, with film after film resorting to traditional miniature explosions. However, in order to create one of *Phantom*'s most spectacular scenes, that trend had to change. "On the Podrace, my first inclination for the crashes was to build miniatures and blow them up," Knoll admits. "But as I began figuring out what kind of frame rate I would have to run at, how fast I'd have to drag these models, what the rig would look like, and how much set I would have to build, it became apparent that it was not really workable. I had to figure out some sort of CG solution to crash these things. There were at least six to nine months of R&D on that before we started making shots."

Knoll and company faced the problem of replicating the randomness that occurs when a miniature is blown up. "We found that a bit of that serendipity actually happens in CG when we're doing simulations,"

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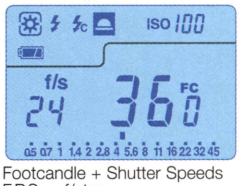

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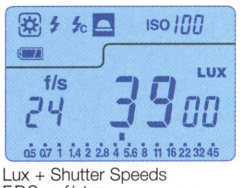

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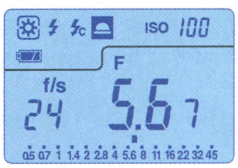

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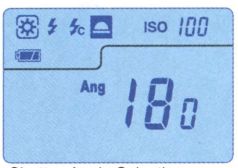

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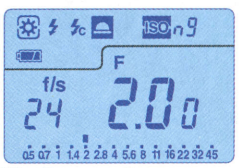

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Knoll attests. "Once we set up the initial conditions, the computer would calculate the physics and proceed. Then we'd look at the take and say, 'See the way this piece hits? It would be nice if it bounced a bit higher and spun faster.' We could actually go in there and make the piece inherit more of the rotation from how it hits the ground. That gave us this nice mixture between the totally planned deliberateness of computer graphics and the serendipity of just seeing what happens."

Before the ILM crew began working on the sequence, Lucas assembled videomatics of the Podrace using found footage from various racing films and World War II dogfight sequences — much the way he had blocked out the Death Star Trench scene for *A New Hope*. Working with Lucas, editor Ben Burtt and previsualization effects supervisor David Dozoretz took footage from the films *Grand Prix, Le Mans, National Velvet* and *Ben-Hur* in order to construct the pace, timing and flow of the Podrace. Unlike the storyboards they replaced, these shots had dynamic movement. The animatics team (spearheaded by lead animator Pete Daulton) then quickly created low-resolution 3-D versions of almost every shot with Electric Image and Commotion software so Lucas could see the sequence with podracers instead of horses and cars. This combination of stills, storyboards, video footage and simple 3-D computer graphics effectively conveyed the narrative of the complex sequence.

The cannibalized film footage was still heavily relied upon as reference material for the final effects shots, and Lucas was eager to replicate the sense of tremendous energy and excitement in the various pieces. "One of the first versions of the videomatics had cockpit-cam shots from real races," Knoll recalls. "When the podracers crashed, there were Indy and Grand Prix car crashes cut in, and there was something really unique and different about the way those crashes looked. When something crashes in a movie, it usually just turns into an orange fireball, but George didn't want that — he liked the look of Formula One car crashes. They've gone to a lot of trouble to make those accidents survivable, so instead of a big fireball, the front sections collapse, parts get shredded, and fiberglass flies all over the place. The vehicles have so much kinetic energy that they just tumble end-over-end. George wanted us to try and match that as much as possible, so I gathered a bunch of crash videos and we stepped through them frame by frame, picking apart what made these crashes look so cool. We emulated a couple of them directly."

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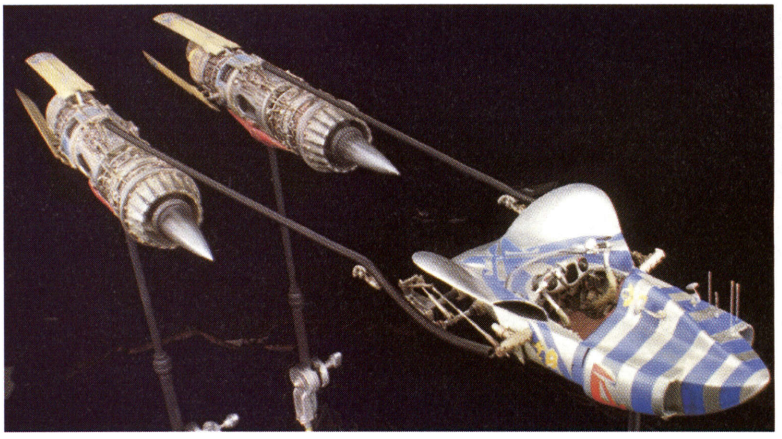

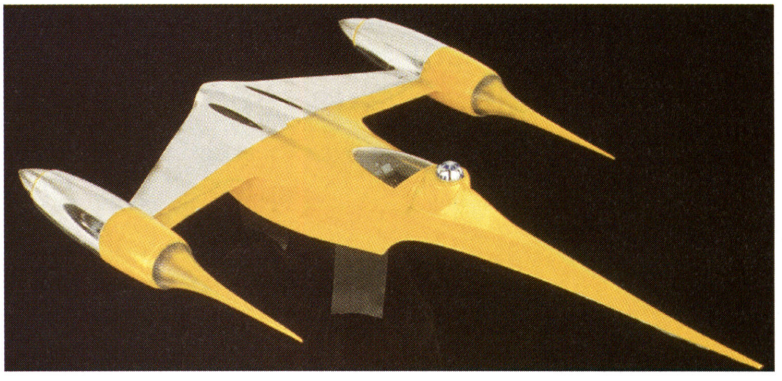

Practical model versions of Anakin's podracer and a Naboo starfighter. Scale-model ships were used extensively to depict parked vehicles, while CG versions would be used to render them in action. The scale models also served as lighting references for the CG hard-surface modelers.

The pods themselves consisted of little more than cockpits attached to twin jet engines. "The pods were big, loose arrangements with engines that floated individually," Knoll details. "The engines were anchored to the cockpit with these cables, and we felt that the whole thing would sort of bounce around. We already had rigid body simulation software that could replicate what happens when an object hits the ground and then bounces, rolls and skids. If we'd tried to animate that by hand, it would have taken an enormous amount of time, and it probably never would have looked right. I wanted to take advantage of the computer's ability to believably simulate that sort of thing."

The trick for Knoll's unit became to replicate the dynamics of motion and simulate the reactions of the pods with each other and the environment — while making the race look as good as if it had been achieved with miniatures. "We went through a lot of trouble to make the movement of the pods look as authentic as such a wild concept could be," Knoll acknowledges. "We created this invisible framework internally in our computers, and all of the podracers were suspended from these 'invisible springs.' Rather than animating every little bounce and bump, we had the pods flying around on this invisible framework. That way, the computer brought a lot of subtle nuances to the motion, which it calculated with physical correctness; the pods had the proper mass and rotational inertia, the engines had this nice bounce, and the effect had all of these other nice aspects that are very hard to animate believably."

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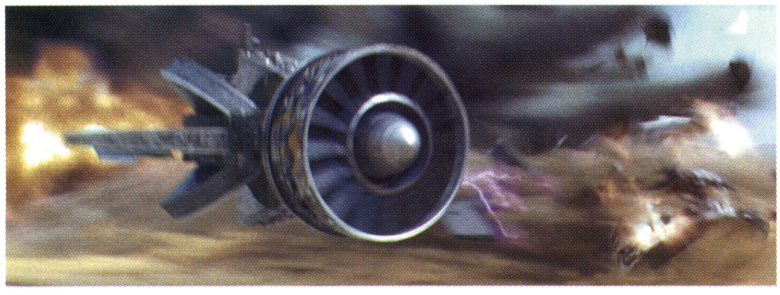

Detail depicting the tumbling destruction of one podracer's ship — a piece of action created in CG. Effects supervisor John Knoll and company faced the problem of replicating the randomness that occurs when a miniature is blown up.

some live-action elements, including Anakin piloting his pod, and miniature backgrounds. Knoll even chose to do a wild blending of live-action with a CG character for the sequence in which the dastardly Sebulba bashes his pod into young Skywalker's machine. "We filmed those shots with full-size props of both Anakin's and Sebulba's cockpits against bluescreen out in the ILM parking lot," Knoll explains. "I just comped the ground plane in behind them. In fact, for all the close-ups of Sebulba in the cockpit, we just comped him into the full-size setpiece. I figured it was simpler to shoot the real cockpit, then matchmove our animation to the bluescreen plate element, rather than putting a lot more energy into making a CG model of his pod hold up that close."

Sebulba's background plates were often shot first, but this was an exception to the general rule. Since the focus in many Podrace shots was on the creatures themselves, animation supervisor Rob Coleman's team would often finish the creatures first, before Knoll's crew created the backgrounds using a variety of elements. "A couple of the terrains in particular — including the Anchorhead Arena where they start and finish the race, the Jag Crag stalactite caves, and a few parts of Beggars' Canyon — were

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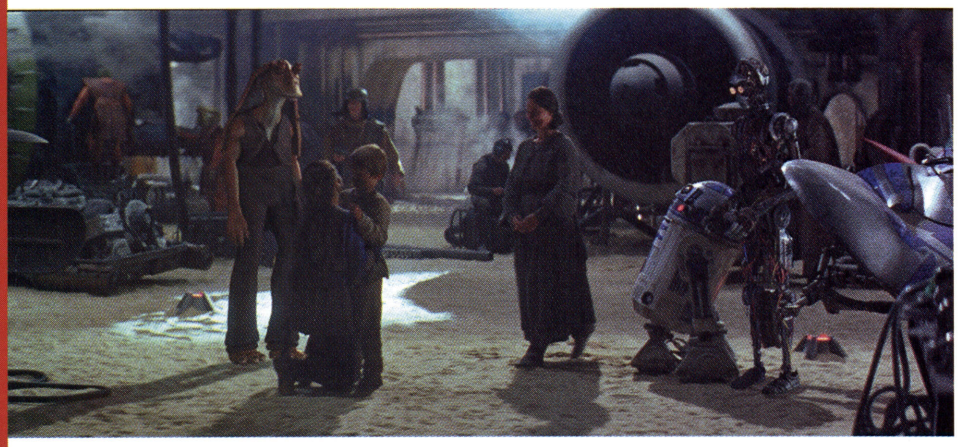
built as very large miniatures," Knoll reveals. "Again, that was to distribute the workload, because creating CG terrain is a very labor-intensive process. We had a group of guys who knew the process and had the eye and the skill to make those landscapes look good, but we just didn't have enough of them to do all the shots. However, we had enough people in the model shop to build that stuff — and enough camera time to shoot it. The miniature landscapes were pretty self-contained environments; we didn't have to blend them into the ground plane, although we still had to comp in CG skies or add something else. It's definitely a mixture there — we did whatever was most expedient."

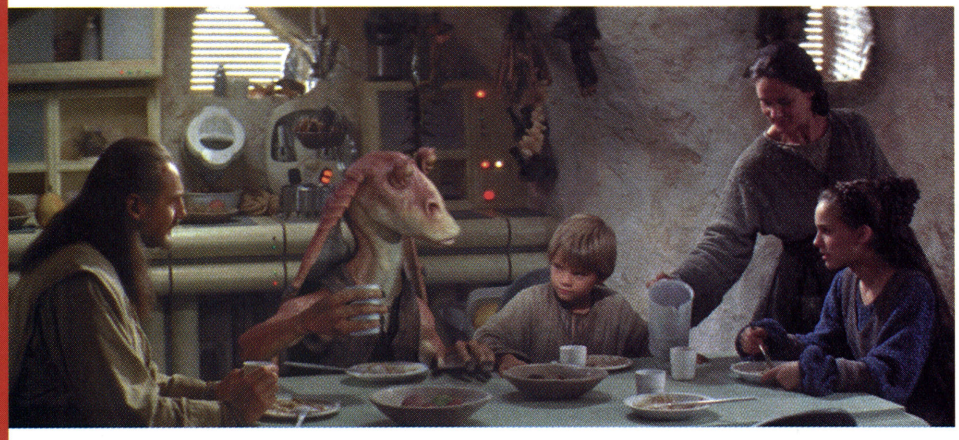
In most of *Phantom*'s effects sequences, the artists found something in each shot — a live-action plate or a bluescreen element — that would ground them in reality. The Podrace was different. "It's a 12-minute scene, and there are large chunks — not just a couple of seconds — where it's all computer-generated and there's nothing real anywhere," Knoll notes. "When you're starting with *nothing* like that, the work can be difficult."

Before Knoll began working on the Podrace, he spent a week exploring Utah's famed Arches National Park, Arizona's Monument Valley and Canyonlands National Park. "I brought two still cameras with me, and I shot tons of reference material," Knoll says. "I did the same thing when we were on location in Tunisia. When I got back to ILM, I was constantly comparing the effects we were doing to my reference pictures. I'd put five images up on the screen — two of which would be photographs I'd taken in Tunisia, and the rest of which would be some of our shots in progress. I'd just stare at them and say, 'The haze is a little more sand-colored toward the ground, so we ought to try and emulate that.' I would constantly be looking back at the reference material to push our effects more toward the photographs that I had."

Knoll and company spent 13 months working on the Podrace, which featured 320 shots, more than three times the number in the space battle. He acknowledges that the Podrace sequence was a lot more complex. "There was a lot of new software being written to figure out how to deal with these super-dense models, and how to do the physical simulations so that the pods would fly and crash; that continued for quite a while before we were really cranking shots out. The first shots each took six weeks to do. Then, as we got into it, we were doing them in a few *days*! Everybody sped up and really got in the groove." ■

Edit-Suite Filmmaking





Avid's Film Composer system and variety of covert visual effects were used during the editing phase to complete *The Phantom Menace.*

by Ron Magid

The most impressive effects in *Star Wars: Episode I* may be the ones you don't notice. Director George Lucas has devoted his career to transforming filmmaking from a production process into a postproduction medium, waiting until the time was right to test his ability to make a film almost entirely in the editing room. It's not difficult to see that Lucas and editor Paul Martin Smith, working diligently with their Avid Film Composer system, have achieved a result that may redefine filmmaking as we know it.

Using extensive storyboards and full-motion animatics, Lucas actually "edited" *Episode I* with sound designer Ben Burtt for a full year before he shot a single frame of film. Smith didn't become involved until production began at Leavesden Studios outside of London; he edited concurrently with the live-action shoot. When the production moved to Tunisia and then Italy, Smith remained in England. "Since the lab [Deluxe (Rank) Film Laboratories] and the telecine house [Midnight Transfer, which handled the show's video dailies] were both in London, I could just continue printing up stuff that needed to be printed up — we didn't print all of the rushes, we just circled takes we thought would have a problem and continued cutting," Smith says. "If there was any problem, I was in contact with George on a daily basis. Before we left London, I think we had about 70 percent of the film cut in a rough assembly, except for the stuff that ILM was creating."

Smith is a veteran of countless commercials and had cut four features before *The Phantom Menace.* He began working with Lucas on the *Young Indiana Jones* TV series, which he says laid the "experimental groundwork for a lot of the stuff we did on *Episode I,* especially the patching-type tricks, which really progressed on this film. Once we found we could do that easily enough, we started doing it more and more!"

The "patching" tricks Smith refers to included splitting actors out of different takes of the same scene and recombining them in new plates to achieve the optimum performance from each character; adding lip movement to accommodate new dialogue; removing lip movement to edit out dialogue; and adding characters to scenes in which they weren't originally scripted to appear. Considering the breadth of editing-room decisions that these techniques offer, it's likely that Smith is the prototype editor of the future. "That's an interesting way of putting

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it," Smith says with a laugh. "George and I often said, 'Had the Avid not been invented, this film would have taken five or six years to make.' Plus, we wouldn't have even gone into certain areas without it. We call it '3-D editing' now."

This complex recombining of individual elements could take place almost immediately after a scene was shot. "As we were putting it together, we were massaging the elements, so it was all part of the cut," Smith explains. "That way, our cutting copy was fairly refined. We had shots where we combined four different takes to create one scene. When we wanted a wide shot of the audience going crazy during the Podrace sequence, I took a section of the [live-action] audience and replicated it something like 20 times, slightly out of sync each time, and arranged the different pieces to give us an idea of what the final crowd would look like. I think we ended up with 22 videotrack layers on that shot. ILM's people later smoothed things out at high resolution."

Once the first leg of the production finished shooting in Europe and Tunisia, the company returned to Northern California. While the heavy effects work was being handled at ILM, Lucas, Smith and Burtt continued editing at Skywalker Ranch. Several compositors worked closely with Smith to assemble the elements he had layered together on the Avid Film Composer, and make them work in the much more demanding theatrical motion picture arena. "Martin came down to ILM to see our dailies almost every day, and I would talk to him on the phone once a week or so," recalls compositor Tim Alexander, who worked on John Knoll's unit at ILM, assembling some 1,100 shots for the Podrace, space battle and other sequences, as well as a few hundred invisible effects shots. "Martin and George would come up with the shots they wanted, and we'd have to pull everything together. They might have two characters in a shot together, but if George didn't quite like the performance of one of them, we'd take the person on the left from one take and the person on the right from another take, and then split them together to make it look like as if it was all the same take. The first takes we split were quite a few shots in Watto's shop, when Anakin [Jake Lloyd] meets Padme [Natalie Portman] and asks her, 'Are you an angel?'"

This approach proved especially useful when the filmmakers were handling scenes involving the film's child actors, such as a shot in which Anakin's friends gather to inspect his podracer. "When we were dealing with five kids in a shot and they were not necessarily doing everything we wanted at the right time, we could just force the issue by combining takes," Smith says. "George might also say, 'I didn't like the way I originally blocked this shot.' In that case, we would reblock the scene. In one instance, we had a high angle on the kids running into the shot, but in the section we wanted to use, they were really just standing around. To fix that, I stole a section of one of the kids running in to give it motion, blew it up, and got rid of Padme, who was not supposed to be in the shot. We did that kind of thing on a regular basis. We also invented shots that weren't in the original plan. For example, we never had a certain wide shot we needed of R2-D2 and C-3PO walking away, so we created it out of four different shots."

There were also shots in which Lucas wanted someone to turn their head at a different time in the same take. "For example, in one scene we wanted Anakin to turn his head toward R2-D2 and C-3PO, but he didn't do it exactly where we wanted

Opposite, top: A celebration set in the Anchorhead hangar was constructed entirely with stock elements of the required characters after Lucas determined that such a shot was needed for dramatic reasons. Opposite, bottom: A dinner scene at the Skywalker home was composed of many shots that were pieced together from separate takes. This page: Scenes featuring Anakin (Jake Lloyd) and Queen Amidala (Natalie Portman) required extensive shot "splitting" in order to create the proper performance chemistry.

Edit-Suite Filmmaking

Using storyboards and animatics, Lucas actually "edited" *Episode I* with sound designer Ben Burtt for a full year before a single frame of film was shot.

him to," Smith recalls. "The solution was to move down earlier into the take to use his head turn. Since the Avid doesn't do morphs, I did a little two-frame dissolve so my timeline would have all of the elements in it. Then ILM did a 2-frame, 3-frame or 4-frame morph just on his head to hide the jump-cut. The shot was also too static for continuity, so we patched in one of our actors from the start and had him walking toward the camera. We then blew the shot up and repositioned and painted in the right-hand side of the missing set."

Sometimes a character was looking entirely in the wrong direction, as in the scene where Anakin and his mother, Shmi (Pernilla August) entertain their Jedi guest, Qui-Gon Jinn (Liam Neeson), at the dinner table. "Shmi was turning the wrong way," Alexander says, "so we actually sliced her head off and then reverse-printed it in the shot."

Lucas and Smith even took a few tips from ILM's work on *Forrest Gump*, for which animators digitally replaced the lips of several historical figures and put new words in their mouths. In the case of *Episode I*, the script was being rewritten as the film was being edited, and Lucas found that he could use this methodology to create new lines or shut a character up completely. "Padme was meant to say a line at the end of the movie after she's won her battle, but George wanted her to say something different. We had Natalie [Portman] record the line, and then we actually changed her lips to match what she'd recorded," Smith marvels. "We did that as a cheat, because it was a wide shot. We actually shot somebody else's lips, pasted in the last eight frames and synched her voice speaking the words.

"We could also get rid of certain lines either by morphing the mouth closed or by using our favorite simple trick: there were a couple of scenes where Qui-Gon was giving Jar Jar a hard time, and we got rid of those lines by inserting a [synthetic] extra walking between him and the camera — just hide the lips, and there goes the line!

"I think it was [director] Bernardo Bertolucci who said, 'Editing a movie is like being a miner. You go into the material mining for the material.' To an extent in the past, we used to be stuck with whatever material we had. Now we've added another level. We can manipulate almost everything."

Of course, not everything that appeared to work on the Avid's monitor translated quite so easily to the silver screen, as visual effects supervisor Scott Squires notes: "Martin Smith would slice-and-dice and do mockup shots on the Avid, and then ILM's editorial department would break down the elements and we'd actually do the shots. For example, we had a shot where Queen Amidala was with some other characters, including R2-D2. We wanted one guy to look over at R2 a bit later than he did, and we had to split that part out so he would turn his head 10 frames later. Now, obviously, when you're looking at the Avid image, the quality level and detail isn't there. It seemed like a neat scene on the Avid, but there were all of these nuances that had to be addressed. In those cases, we'd often find problems later on, when we were actually working on the shot. If, say, the Queen's reflection appeared in one spot on R2's domed surface but needed to be someplace else, we'd have to split those elements on R2's head. But then shadows would cross, which shouldn't be happening. Getting all of those little details right took time. I must say that we had a great crew, though, which made that type of work fairly straightforward and par for the course."

Because the plates that would later feature animated characters were shot empty, with actors voicing those characters off-camera, Lucas would often have Smith put a version of the character into the empty plate just to get a feeling for what the final shot would look like. "For instance, I would take Ahmed Best in his Jar Jar costume and put him where we wanted him, or float a maquette of Watto in the plate," Smith says. "We would literally use that as a patch, which was quite funny. If George wanted Jar Jar's head staring at Qui-Gon or whatever, I'd find a head turn and do a freeze-frame so it kept its direction. That way, [animation supervisor] Rob Coleman would know exactly where the eyelines should be. We wanted to get the animation sequences as close to completion as possible so Rob's team could get to work on them."

However, Lucas wanted something more from his animators than just photo-realism and believable, nuanced performances. Several years ago, director Stanley Kubrick had talked with Dennis Muren, ASC about creating an all-digital character for his planned but unfilmed feature *A.I.* Kubrick insisted that he would need extensive "handles" — lead-ins and lead-outs from the prospective beginning and ending edit points of each shot — in order to integrate the CG character into the film like a real actor. Lucas expected handles as well, which additionally taxed his already overburdened animators. "Knowing that George might change his mind and want to extend shots, we fought like

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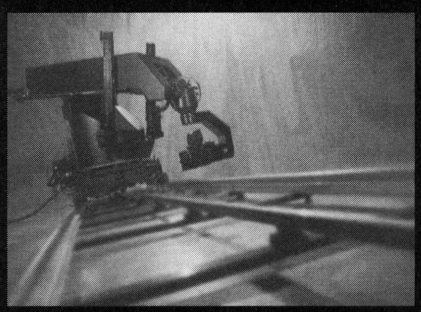

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mad to get 16-frame handles on the effects shots, which is unheard of in CG work," Smith states. "Because of that, we reminded the animators, 'Remember, frame one is not your first frame; it's there only if we want to extend the shot.' Since we had 16-frame handles, we were usually trying to cut in on frame nine, which was meant to be our first frame. We therefore asked the animators to make sure the CG characters didn't blink around frame nine! The CG characters would often be saying part of their dialogue in those previous eight frames, which allowed us to cut in the middle of a line or before a line; that was very handy not only in dialogue scenes, but in all sorts of fight sequences. I think we used handles on a lot of the shots. It got quite funny — I would go down to ILM every morning and sit with some of the groups in dailies, and John Knoll would turn around and ask, 'Martin, do you remember if you used the handles in this shot?' I'd have to say that about 20 percent of the time, I had to go back and look to see if we'd used the handles or not! However, if we needed a shot quickly and felt we didn't need the handle, I'd just say, 'Give me what you've got.'"

Sometimes, ILM was asked to create shots Lucas hadn't realized he'd need. "They'd grab pieces from all over the place that hadn't been designed for the shot, and then mock it up on the Avid by shrinking all of the pieces down and putting them where they thought they should go," Alexander says. "We'd then stick it all together into a shot for them and try to make it look great."

One rather difficult example of this technique involved a celebratory wide-shot inside the Podracer hangar after Anakin's triumph. The entire shot in which Jar Jar picks up the boy, Shmi embraces him, and Padme and Anakin's friends congratulate him was entirely pieced together from "found" elements. "That was a sequence of about five shots that they added maybe two-thirds of the way into the post schedule," Alexander notes. "John reshot the hangar miniature for the left-hand side; there was also a whole live-action plate that filled the right side of the frame, and a few CG elements like Jar Jar, along with several other characters, including Padme, Shmi, R2-D2 and C-3PO, that we had shot against bluescreen. Those bluescreen elements weren't created specifically for the shot in question, though — they were filmed because George knew he wanted to do a little celebration at the end of the race. As the story came together, he decided he needed that particular shot.

"Qui-Gon Jinn was in those original shots, but in the movie, he's up in Watto's box. We needed the Padme element, which was also in there, so we had to remove Qui-Gon from those plates. Once we got the elements online, we just started throwing them all together, which took us a fairly long time. Normally, I'd say that type of thing would require three to four weeks of work, because it was one of the more complicated shots. At the speed we were working, however, we were able to put it together in about a week and a half."

As the editing process continued, there were times when certain shots just didn't fit, even if they happened to feature costly visual effects. "When we began getting into the overall rhythm of the movie, there were a fair amount of finished shots that just disappeared," Smith admits. "We couldn't know that until we had those shots, so in a sense, ILM was giving us the second set of rushes!"

The Avid editing system also presented some unique issues, since it wasn't quite designed to handle the workload that Lucas and Smith had in mind. "When we first told Avid, 'We want all of our footage online so

we don't have to shut down and switch over to different towers,' their initial reaction was, 'Well, we can't guarantee more than 300 gigabytes,' Smith recalls. "We were going to push the limits of Avid's system, but their ground troops in London were amazing. They said, 'Don't worry. We'll make it work for you.' Those Avids had to be built, and they were definitely pushed to their limit — [postproduction supervisor] Mike Blanchard spent many a night from 8 o'clock until 5 in the morning making sure they were running. I think we left London with something close to 600 gigs online."

As in any experimental situation, a number of lessons were learned during this phase of *Phantom*'s post. "We did a lot of repositioning in the movie — blow-ups and zoom-ins, static shots that became moving shots, and so on — but there was no great correlation between what we were literally doing on the Avid and what ILM was doing with their system," Smith laments. "We were working in quarter-fields on an older Avid system, but we couldn't move up to a later software because we had too much material online. In the end, ILM's artists were eyeballing what we did, which is always difficult — especially since the monitors weren't set up the same way, which increased the potential for problems. There are a whole bunch of issues that we're working with ILM to improve, like being able to translate digital positioning to pixel positioning, and figuring out how to get the information quickly from my Avid straight to the people that are working on each shot."

Even more demanding was keeping track of all the diverse elements, from Smith's reconfigured Avid shots to ILM's final composites. This difficulty was compounded by the fact that Smith was also the visual effects editor on *Phantom Menace*. "As you know, effects shots always have a specific number, but we'd

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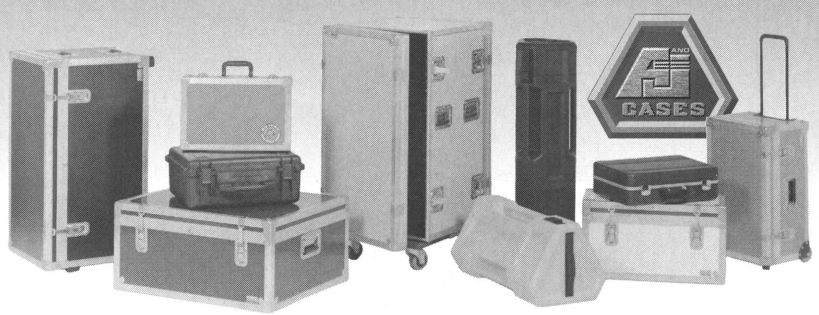

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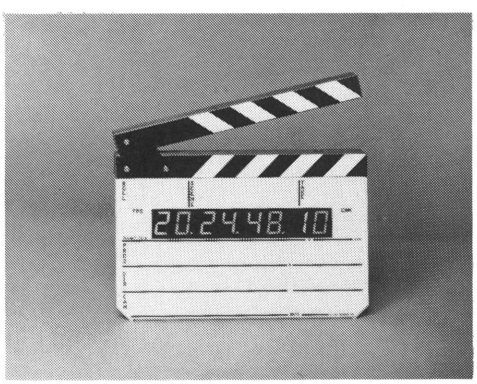

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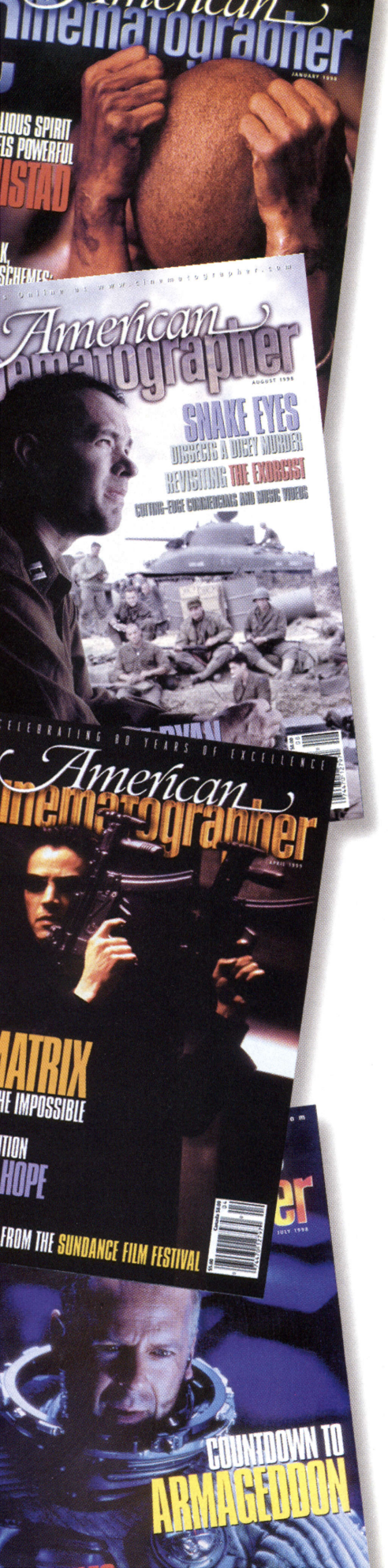
numbered every single shot in the movie, because we knew that somewhere along the line, they would be manipulated," Smith emphasizes. "Over the course of the project's last year, I would have a little conference over our T-2 line with ILM at the end of each day of cutting. They could view my work over the tie, and I would take them through each shot, telling them what I'd done. Every night, the cut was transferred down to ILM, so their Avids would have my cuts. Paul Cichocki, our visual effects editorial coordinator, had an Avid and kept track of every single shot. [Visual effects editors] Scott Balcerek and David Tanaka had a whole team whose job was to literally flag whatever changes we did on a daily basis, and give all of the details to the different departments on each specific shot."

Nevertheless, communication was still a bit of a problem. "It always is with something this large and with this many people involved," Smith confirms. "I'm incredibly proud of how ILM and my department worked it all out, but there's still room for improvement. For example, we had to constantly remind people working on individual shots that there were shots on either side of it, and that there was continuity across those shots. Virtually the whole movie involved effects, so those kinds of things could sometimes slip through the cracks. Solving that problem would save money and time."

Another issue that Smith is eager to resolve is the huge amount of paperwork necessary to keep track of all the elements. Instead of looking through heaps of celluloid to find a trim, his team found themselves shuffling through piles of paper. "It's very ironic," Smith concludes. "Although we had an amazing database, we used a mountain's worth of paper. In the age of computers, there must be a way of getting around some of that!" ■



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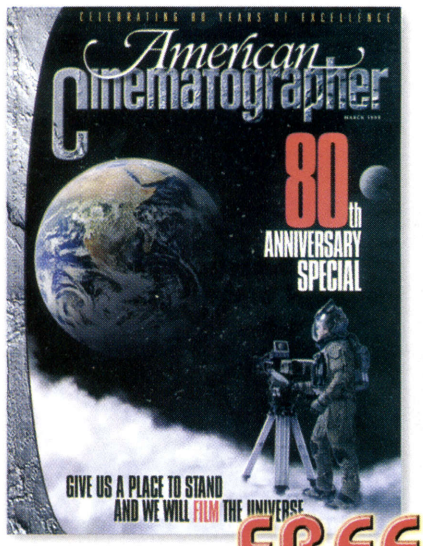

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by Debra Kaufman

Feature filmmakers often wish they could use the same tools as those routinely employed for commercials and TV programming — cinematographers always want a higher degree of control over the look of the film, while editors long to be freed from the limitations of the film lab. At the Digital Film Lab in Copenhagen, Denmark, they can get their wish — for the same costs of traditional laboratory processing — via a pioneering system that scans an entire feature film into the digital realm.

It may sound too good to be true, but Kris Kolodziejski, CEO of the Digital Film Lab (co-founded by two Danish post houses, Destiny 601 and The Warehouse), firmly believes that his facility's "digital film processing" system is about to become the wave of the future. "We anticipate that a number of systems like this will be established in the near future in other countries as well," he opines.

Up until now, feature films have relied on the digital process solely for visual effects sequences; the appropriate film footage was scanned into the system, manipulated and recorded back out to film. At about the same time that the filmmakers of *Pleasantville* worked out a system to scan nearly all of that picture into the digital realm (see *AC* Nov. '98), Kolodziejski also began to put together the pieces of a system that would enable him to scan an entire film at high resolution.

At the front end of the process is a Philips Spirit DataCine, currently the only scanner fast enough to make the process viable, and one that would enable the material to be graded at the telecine stage. The next question, says Kolodziejski, was how to tackle the grading of a feature's 1,500-plus cuts. "A very simple solution was to assemble the neg, with 'handles,' into sequence," he reports. "This made it possible to use tape splices instead of cementing, and speeded the grading up tremendously. Today, we normally take between 40 and 50 hours to grade a feature."

The stylish interior of Digital Film Lab, one of the first facilities in Europe to offer digital-intermediary services.

Once the material is in sequence, it's graded on the Spirit. The negative cutters then create a new EDL representing the new time-code numbers. The picture data is next loaded into their Discreet Inferno, which currently has one terabyte of storage, a number that will soon be doubled. The Inferno also features enough I/O bandwidth to play back 2K files in real-time on a 24" monitor. "From the beginning, we were sure that all of the material had to go through this stage, since every scene could potentially qualify for some kind of enhancement," explains Kolodziejski.

Once the original Avid EDLs have been converted by the negative cutters to reflect the new source codes and the Inferno's ability to read time code from dpx data files (a version of the Cineon file format with embedded time code), the assembly of the reels is an automatic process — complete with dissolves, speed changes, wipes and other optical effects. It's also a very fast automatic process, as Kolodziejski maintains. "It is quite impressive to see the system auto-assemble a reel with, say, 400 edits, a number of dissolves and speed changes at about five to 10 minutes per reel," he says. "It takes 10 to 15 minutes per reel to auto-assemble an entire feature film, depending on the number of optical effects. At the lab, it would take one to two months to do all of the optical work. Cutting the EDL for the trailer is also an automatic, one-minute process. Plus, with our system, everything is first-generation material."

The last part of the process is to re-record back to film. On August 1, the Digital Film Lab acquired Arriflex's new laser recorder, the Arrilaser. Kolodziejski testifies that the recorder is both fast and economically viable, recording to intermediate stock at 5.5 seconds per frame at 4K resolution. With the Arrilaser, the Digital Film Lab hopes to be able to record a 90-minute production in about 10 days, creating both internegatives and interpositives.

The advantages of this "digital lab process" abound. The director of photography can grade the film interac-

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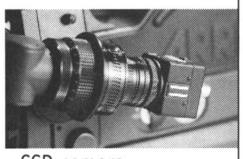

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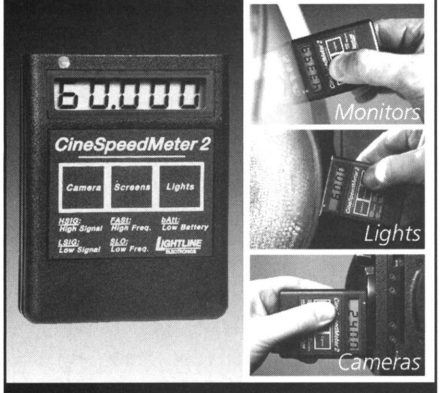

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tively in sequence, while controlling contrast and saturation; manage different gradings in shadow, midtone and highlights; perform dissolved grades; mix formats; reframe; and avoid the compromises inherent to optical blow-ups and dubs. At the workstation stage, the director has access to a gigantic toolbox for effects work at any point of the film. Since every frame is in the Inferno workstation, it's easy to make repairs, adjustments and enhancements.

The editor also reaps benefits. He or she has all the tools of an offline system, without the penalty of reduced quality and increased lab costs. It's possible to use any number of transitions (of any type and length), speeds and freeze-frames, or to re-use material, and these optical effects are automatically applied to the footage. The entire process is fast, flexible and economical, and the end result is high-quality first-generation prints and TV masters. "Every single editor, cinematographer, director and producer who has tried this process has not wanted to go back to the traditional route," Kolodziejski maintains "We have also seen that when the tools are available, they are immediately used."

To prove his point, he notes that the first feature to go through the system, the Swedish production *Zingo*, went from being a completely "non-effects" production to one that contained 200 speed changes and dissolves, 70 effects scenes and an animated title sequence. The Danish production *In China They Eat Dogs* also benefitted from the system's speed. After becoming mired in a film lab just five weeks before its Cannes debut, the production moved over to the Digital Film Lab, where English subtitles were generated at the Inferno stage and the project was finished before the deadline. According to Kolodziejski, the facility is currently booked to handle 10 feature films, including *Wisconsin Death Trip*, an HBO/BBC co-production.

It's not just feature films that stand to gain from the digital lab treatment."Creating a TV master of a film is an interesting issue," recounts Kolodziejski. "Until now, we have 'downrezzed' the data to a 16:9 PAL version instead of transferring the print or IP, as is normally done. This produces a far cleaner and crisper result. With the new 24 fps progressive HD format, we will be able to output a 1920 x 1080p master, from which any other format — HDTV, PAL and NTSC, in both 16:9 and 4:3 — can be derived.

"The HDTV master will be done straight out of the Inferno, and the quality of the masters that come out of this system are incredible, " he continues. "As electronic cinema projections become a reality, we think the 24p format will be perfect for that purpose."

For those interested in assembling their own digital lab, Kolodziejski cautions that the biggest challenge is calibration, with an ultimate goal of consistency "from the TV monitor at the telecine to the computer monitor at the Inferno to the print."

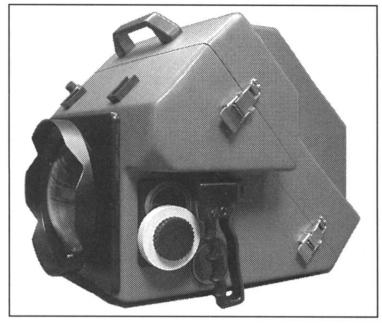
Digital Film Lab, 011-45-3-927-1001, fax, 011-45-3-927-1041.

Ready to Get Wet

Sun Valley, California-based Pace Technologies recently unveiled an array of new camera and lighting gear designed for underwater use.

Pace's ergonomically designed WetSet 435 Underwater Housing features reflex viewing and a natural comfortable shooting position, and is engineered to provide superior imaging in diverse settings. Designed for PanArri 435ES and Arriflex 435ES cameras, the Pace 435 System supports the most popular lenses. The system is also completely compatible with the new Underwater Pan & Tilt WetHead (see below for more information).

Like all Pace housings, the shell of



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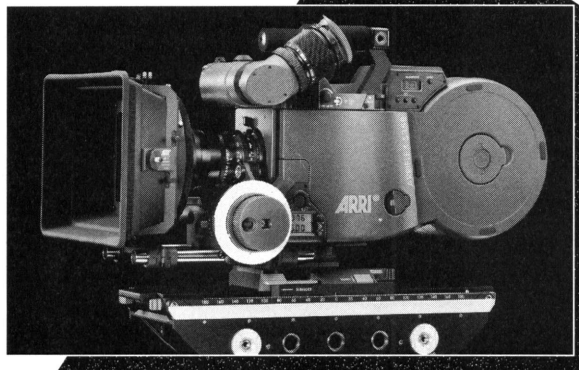

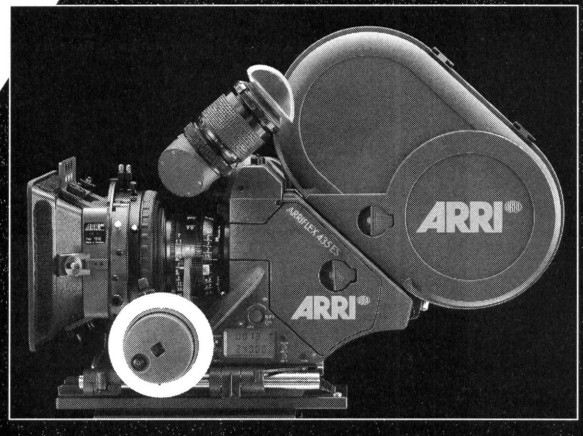

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the 435 design is diagonally bisected with a precision-machined seal. The upper slice lifts off to provide access to the magazine and batteries while the camera is still in the housing. Since it's not necessary to disconnect cables or remove the camera, battery and magazine changes take only 2-3 minutes. The housing's external controls interface directly with the lens gears. When engaged, the ball-bearing transmission precisely adjusts the camera's iris and focus settings.

Many other underwater systems suffer from a pendulum effect, which occurs when a housing is improperly balanced — usually because it is built with the majority of its weight on the bottom. Pace's system is neutrally balanced. Its weight is equally distributed, making it easy to operate in any shooting position. The housing, constructed of anodized marine-grade aluminum, weighs under half a pound in water.

In 1998, Pace Technologies designed and built the first completely transparent and user-friendly camera splash bags. Constructed of heavy-duty materials, Pace's state-of-the-art WetSet

SplashBag was the first to offer complete access to key camera functions while protecting gear against harsh elements and wet environments.

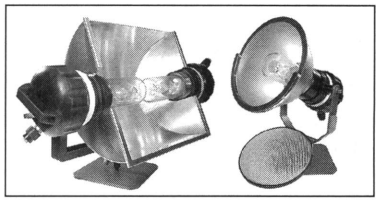
Designed for use with Panavision's Millennium, Platinum and Gold cameras, as well as Arriflex cameras, Pace's 35mm lightweight SplashBags provide superior protection when the camera is operating in heavy rain or water-level scenarios. Cinematographers operate functions via a remote focus and iris control, while the camera is safely enveloped in the see-

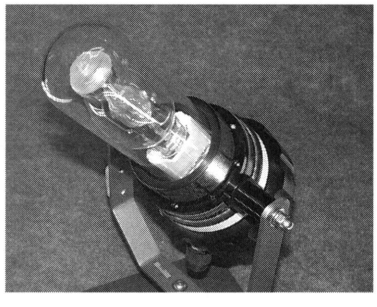
through case.

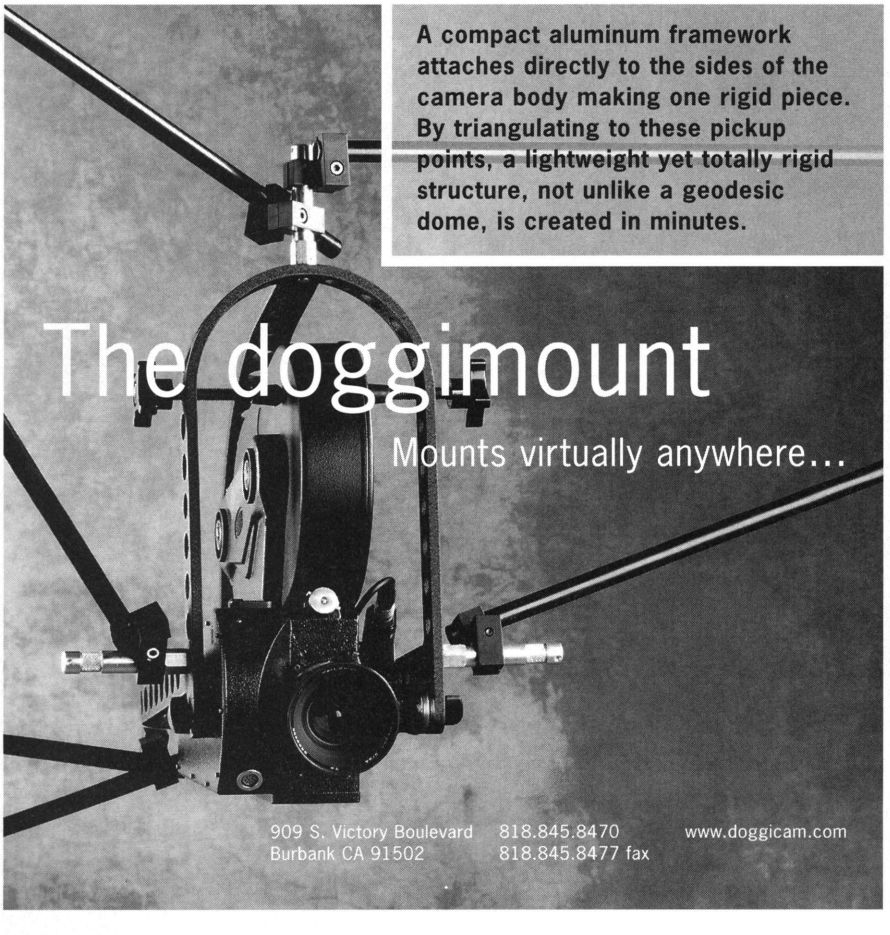
The WetSet SplashBag can be mounted on hotheads, tripods or a custom-designed shoulder bracket for handheld shooting. An optional lens-blower system is also available. In addition to 35mm splash bags, Pace Technologies also offers bags for 15-perf/70mm cameras, the Arriflex 16 SRII and III, and Moviecam platforms.

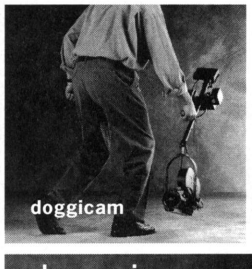
The Pace Pan & Tilt WetHead operates in a completely submerged environment, providing full pan and tilt motion control of the camera in its Pace underwater housing. This system can also be mounted to a crane instead of a tripod, allowing the operator to literally fly the camera through the water like a model airplane. The WetHead is fully compatible with Pace's Splash- and Full-Protection 435, 35mm, High-Definition and Digital Betacam housings. The Operator Control Box is powered by either GFCI-protected 110v or 24v DC. Using cable increments of 100', the operator can drive the WetHead from a dry position up to 200' away.

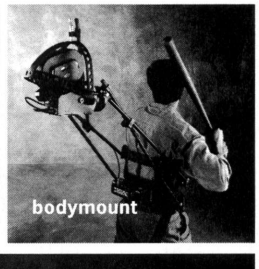
With Pace's new Modular Multi-Environment Lighting System, a single, unique bulb enclosure can be made to function as a cyc light, Par light, or fill light by changing the reflector. Pace offers 5K or 10K tungsten and 4K or 8K HMI sources that can operate in wet or dry locations. For extreme environments, such as fires or floods, Pace has designed the WetLite, a patent-pending design that incorporates either a tungsten or HMI globe (from 2.5K to 12K) completely enclosed in a water-filled housing. The water is constantly circulated to maintain the fixture's internal temperature so that the lamp can be completely submerged — while burning — in cold water, or subjected to raging fires without affecting the temperature of the lamp itself. ➢











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Over the past 10 years, Pace Technologies has contributed its wet-environment equipment to features such as *Titanic, The Abyss, Sphere, Storm of the Century* and *Deep Blue Sea.*

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Egripment's MiniRoll

Egripment has introduced an add-on third-axis system, the MiniRoll, which is designed to complement its existing MiniShot pan-and-tilt equipment. The MiniRoll enables a complete 360-degree range of camera movement for units weighing up to 6.6 lbs. The unit is installed on all MiniShot remote heads and is controlled via a joystick that now includes a separate thumb switch for control of the roll movements. The replacement joystick allows for greater creative control and possibilities when designing shots. The unit offers variable speed control, a reverse switch, and the company's standard electronic dampening system for smoother starts and finishes.

Egripment Support Systems, (818) 787-4295, fax (818) 787-6195.

Strand Spotlights

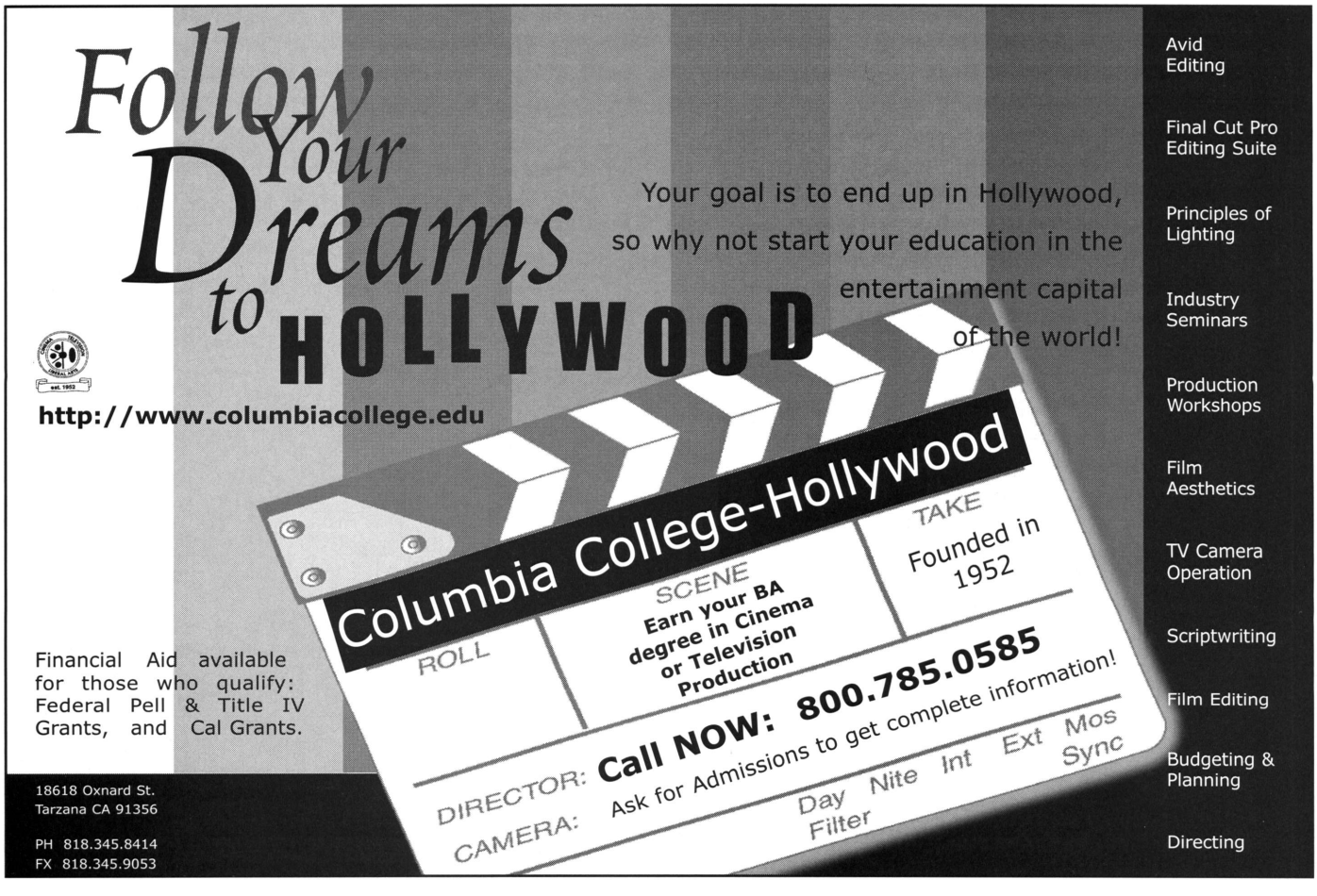
Strand Lighting is now offering its SL Series Spotlights, a series of eight units created to provide ease of hanging and maintenance while generating strong light output. The range consists of six fixed-focus lights (with beam angles of 5, 10, 19, 26, 36 and 50 degrees) and two zoom-variable spotlights (with ranges of 15-32 or 23-50 degrees). The SL Series is capable of 360-degree rotation, offering fast and accurate focusing for any shutter or gobo position. The system's glass reflectors are dichroic-coated, thus extending gel, shutter and gobo life by reducing the amount of heat exposure. Aspheric, computer-designed lenses allow for accurate focus across the full beam.

Maintenance of the lights is facilitated by easy access to lens and reflector cleaning, and the lenses are color-coded for easy replacement. The lamps are changed with a bayonet-action system that prevents inadvertent adjustment of field settings, while off-center pivot points allow for quick and close hangings. Positioning of the lamps is also easily adjusted, given their large rear handles. Moreover, lighting options are enhanced by the series' compact size, as well as features that include wide gates for drop-in lenses, lamp houses with interchangeable lens tubes, and rotating pattern holders. Dual color runners feature integral safety catches and offer room for glass color filters.

Strand Lighting, (310) 637-7500, fax (310) 632-5519, website: www.strandlighting.com.

New Lightning Effects

Tek Lighting Corp. of Brentwood, Tennessee introduces their Xenon Striker Lightning Effects System, a patented design that converts AC to DC, and combines the DC power with internal



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capacitors to increase the light output while eliminating excess draw on the power source. The Striker 1, a 65K, 120v AC Lightning simulator, was the first in the line, and has been out in the field for just over a year. Soon to be released are Tek's Striker 2 (125K 208/240v AC) and the Striker 3 (250K 208v AC). All three lamps feature low-pressure DC Xenon non-explosive lamps, rain-resistant housings with dual fans and lamp cooling, tempered glass, an oversized reflectors and front faces for a broad source output. The Strikers can be fired singularly or with any number chained together. Each striking can feature random undulation or matched undulation to each fixture in the chain. All of the Tek system fixtures feature a ballast-in-the-head design that eliminates the need for excess feeder cables. The Tek system's design eliminates low voltage problems and shutdowns caused by overheating.

Tek Lighting Corp., fax, 615-370-3380, e-mail: xenon@bellsouth.net, website: www.teklighting.com.

Kino Flo Power Support

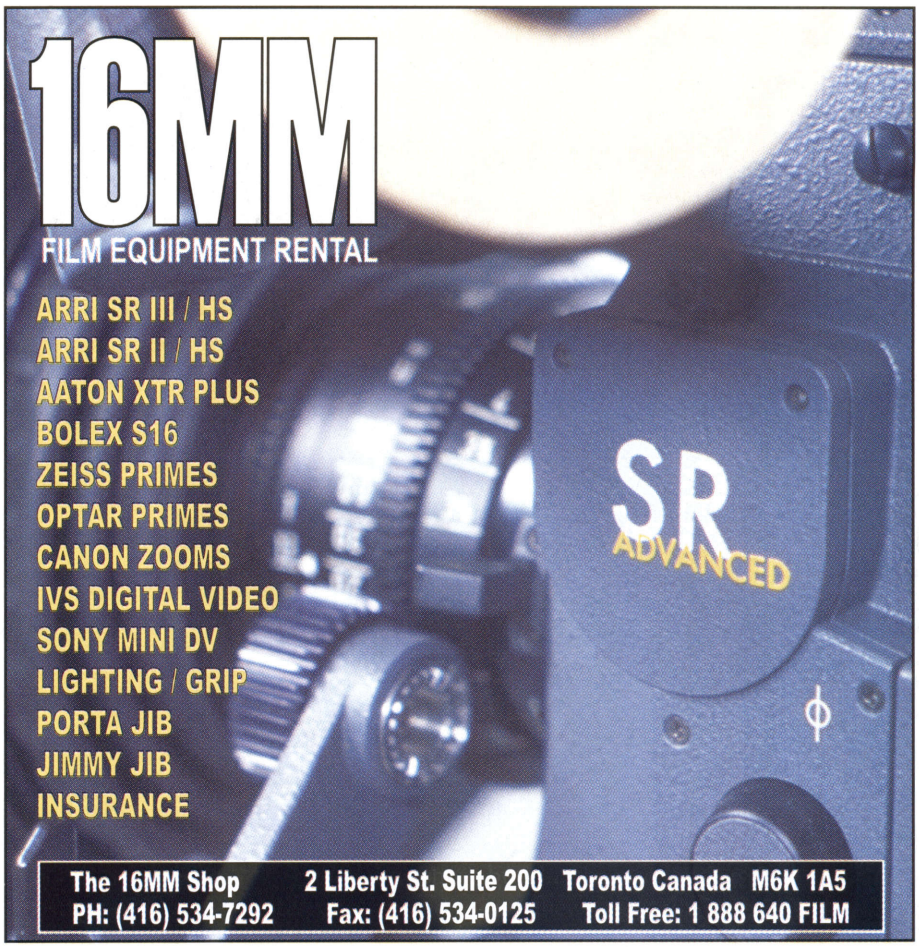
Kino Flo Incorporated has taken at step away from their usual luminescent work to present a new line of DC power support systems for location and stage work. At the top of their new line is the 1800W Inverter, a compact kit that includes an 1800W sine-wave inverter, two 40-amp chargers and two 194-amp-hour gel-cell batteries. The system is designed to be small enough to fit into most cars, and is ideal for use on a bus or subway. It features silent operation and a true sine-wave signal that is indistinguishable from AC power provided by the utility company. The inverter also allows AC feed-through to save battery power during prelight and setup near an AC power source. When the AC is disconnected, the inverter automatically switches to battery power without interruption in power, so there is no need to restrike HMIs or Kinos that are powered by the inverter. The system has a quick recharge to 75 percent capacity in 2 hours and 20 minutes, and can cycle between three batteries for an uninterrupted supply of power. A five-second

high-surge capability of 2900W allows the ability to utilize many types of HMIs and hard-to-start loads.

Within their power-support line, Kino Flo has also unveiled a line of Ni-Cad batteries for camera and lighting. A blend of proprietary electronics and rugged construction (including stainless-steel screws) contribute to a long life. Ranging from 12v to 30v, Kino offers several different batteries for just about any application. At the heart of their new line is the Maxi-D Charger (designed by Elemer Nyiry of Cinepower Int.), which rapidly charges 12V-32v Ni-Cad batteries. When used with Kino Flo batteries, the Charger ensures a two-year lifespan (up to 3,000 cycles) without re-celling. The Maxi-D automatically detects the state of battery charge and charges at the appropriate rate, eliminating the need to completely discharge batteries before connection. The Maxi-D can also remain connected to the battery indefinitely without fear of overcharging, since the charger will automatically switch to "trickle-charge" after completing the charge cycle. The Kino Flo battery line includes the Powerhouse, Dolly Pack, and Wizard (12/24v or 13.2/26.4v for camera use); the Powerbank (15/30v for lighting use); and the PowerBelt (24, 13.2 or 30v for camera or lighting use).

Finally, Kino Flo presents the mica IL-60 rechargeable flashlight. A 10, 20 or 30W quartz lamp with a conventional design representative of camping flashlights, the mica features a clean, even beam pattern without the hot spots, or "holes," commonly associated with most flashlights. Two different light settings ("low" and "high") present a 1½-stop difference, and a temperature change of just 360°K. The 6v Ni-Cad battery allows for a one-hour burn time on the "high" setting and about 20 minutes more on "low." Explosion-proof and watertight, the mica will also float upright. With the mica spot beam, the 30W version will produce a 3' diameter beam at roughly 45', with a footcandle reading at that distance of about 20.

Kino Flo Incorporated, (818) 767-6528, fax (818) 767-7517, website: www.kinoflo.com. ➢



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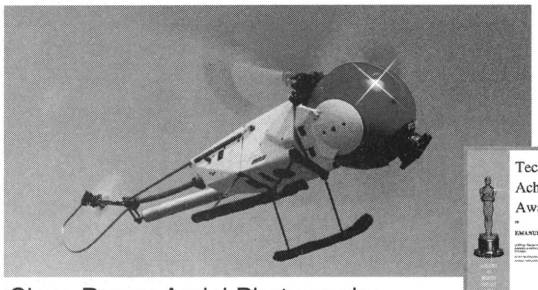

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35 MM REFLEX

The Fries model 435 is a new general purpose MOS production 35mm camera. With its optical printer compatible register pins, steadiness and 150 FPS speed. The 435 is ideally suited for special effects, commercials or any photography where a quality steady image is desired.

The 435 is a spinning mirror reflex camera with a 170 degree blanking shutter. The internal 30VDC motor runs the camera from 2 to 150 FPS forward and 2 to 50 FPS reverse, in one frame increments all crystal. The camera is equipped with take-up and supply torque motors.

There are both 1000 ft. and 400 ft. displacement type magazines. A new feature is the light valve which allows the operator to direct all the light to the viewing system, or to the video assist, or combo which splits the light between both viewing and video assist.

35 mm, Reflex Camera

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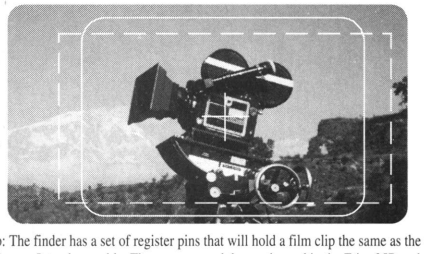

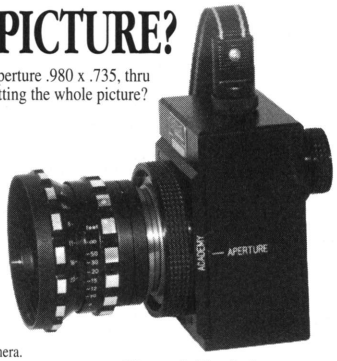

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Mini Grip Kit

Table Manners, a Salt Lake City, Utah company, has introduced a line of miniature grip equipment for tabletop work. Table Manners Grip Equipment System is designed to make all tabletop work easier and cost effective by miniaturizing the concepts of grip support and fabricating them out of a high tensile plastic as opposed to steel and aluminum. The lightweight system incorporates standard ¼-20 threading to accept existing grip equipment and support HMI Mini Pars, Inkies, Dedos, Mini Kinos, dots and fingers, postage stamps, showcard or foamcore — pretty much any small object in a tight space. The system is entirely modular to allow any configuration necessary, and can stand on its own or clamp to existing rigging. Some elements of Table Manner's new line include: suction cups, miniaturized sand bags, 3", 6" and 12" lengths of flex arm and and "A"-clamp accessories.

Table Manners Grip Equipment, 877-323-7080, web site: www.tmanners.com.

PDI Offers New Options for Commercial Work

Under the direction of a newly appointed executive producer of its Commercial Division, Pacific Data Images (PDI) announced the expansion of its facility into a one-stop commercial production studio specializing in CG animation, visual effects and live action.

Since the theatrical release of *ANTZ* last year, PDI's Commercial Division has covered new and historic ground in spot production. Now structured as a stand-alone creative animation, visual effects and live-action division, PDI's commercial unit features an extraordinary team of directors, designers, animators and producers, recruited from the ranks of the industry's best and brightest. At the helm of the division is executive producer Jennifer Thomas. Her production background includes visual effects and live action for feature films, television commercials, music videos and short films for a range of clients and agencies. Most recently,

she completed an entirely PDI-produced international live-action/CG package for Pepsi. Prior to joining PDI, she produced the KFC's "Little Colonel" campaign for Young & Rubicam/NY. Additionally, Thomas was part of the visual effects production team that won the 1999 Academy Award for Visual Effects on *What Dreams May Come*. She also produced the San Francisco location segments, for the pilot and several seasons, on the series *Party of Five*. Thomas began her career nearly 15 years ago working in traditional cel animation with Ray Seti at Sunflower Films in New York.

"Jennifer's diverse experience from CG to live action, stop-motion, broadcast graphics and visual effects, combined with her level of professionalism, is pivotal to our plans to grow our Commercial Division into the ultimate source for both live-action and CG commercial production," said Jim DeRose, PDI's President and CEO. "We are thrilled to have Jennifer heading up the Commercial Division. She is serious about its success and about furthering PDI's goal to become a one-stop commercial production powerhouse."

PDI's Commercial Division is currently working on several spots for leading national agencies, including a broadcast campaign in conjuction with San Francisco-based Foote, Cone & Belding to launch Sega of America's highly-anticipated new gaming super-console, the Sega Dreamcast.

While in production on *ANTZ*, PDI's first feature-length animated co-production with DreamWorks, the stand-alone unit hit the ground running in 1998 to produce a wide range of commercial spots, including Dodge, Gatorade, Jet Dry and Circle K.

PDI, website: www.pdi.com.

New Panasonic HD Monitor

Panasonic Broadcast & Television Systems Company has introduced the BT-S915DA, a 9", high-performance monitor that is compatible with both 525i and 625i component signals. Designed for use by broadcast facilities with DTV systems, the BT-S915DA can also be

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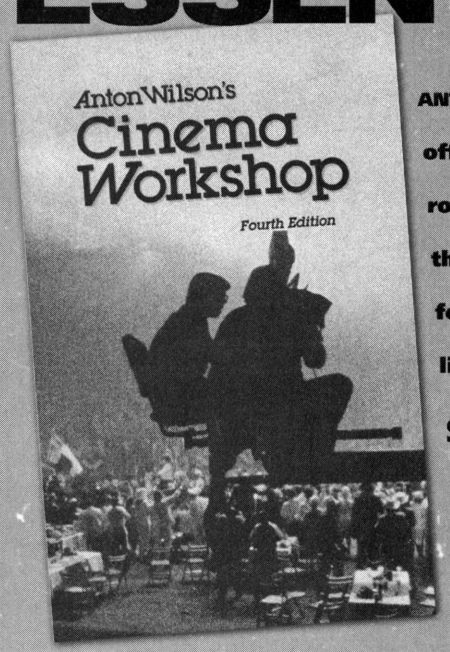

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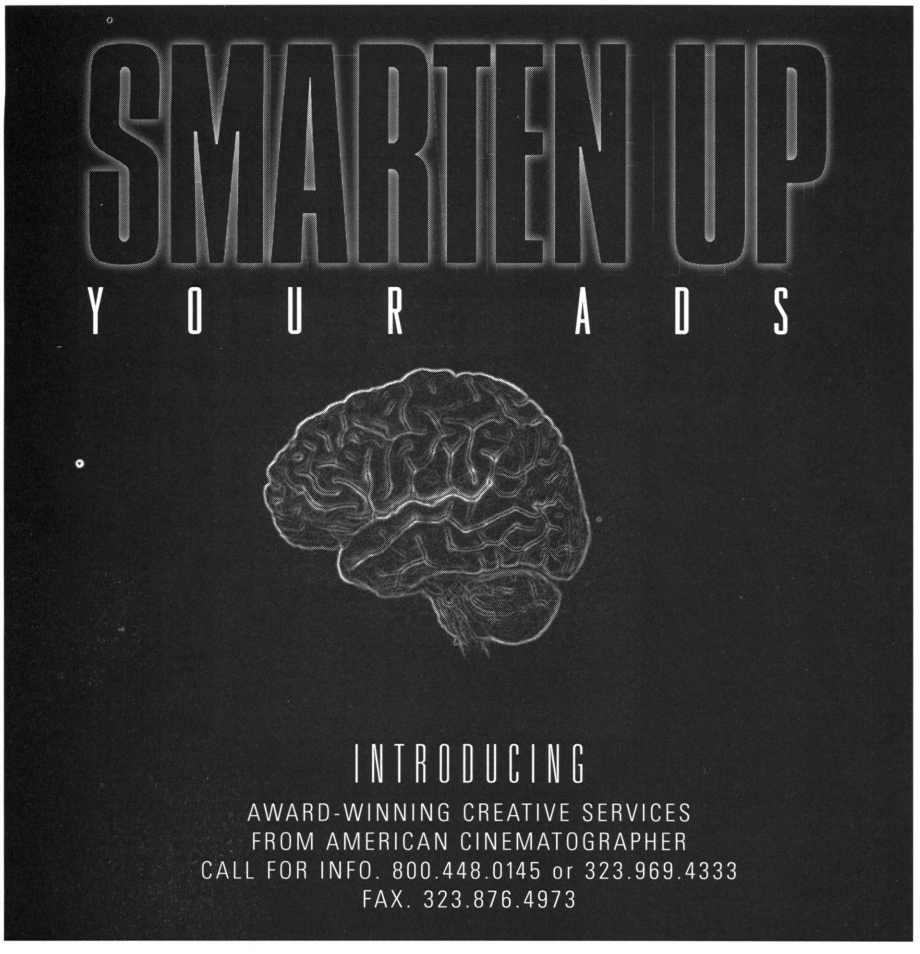

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used for monitoring digital signals via an optional serial digital interface.

The compact BT-S915DA displays both conventional 4:3 and widescreen 16:9 aspect ratio images for monitoring a variety of picture sources. The monitor's inputs include looping NTSC composite, S-Video, YPbPr, RGB, and external sync. The optional serial digital interface (ET-SD06U), which attaches to the rear, allows the BT-S915DA to serve as a monitor in digital broadcast systems based on the SMPTE 259M standard.

Compatible with NTSC/PAL/SECAM color systems, the BT-S915DA delivers more than 300 TV lines of horizontal resolution, a 90-degree deflection and 0.50mm dot pitch. Frequently used controls are neatly arranged on the front panel; in addition to these basic controls, functions for a wide range of professional applications can be operated with the onscreen menu. The monitor's rotary encoder facilitates high-precision control.

Other notable features include: underscan; the ability to mount two units side-by-side on an EIA standard 19" rack; selectable temperature (6500°K/9300°K/user preset); a built-in speaker; and 1W (10 percent) THD audio power output.

Panasonic, website: www.panasonic.com. ■

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Eyes Wide Shut
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Cinematographer:
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The Sopranos
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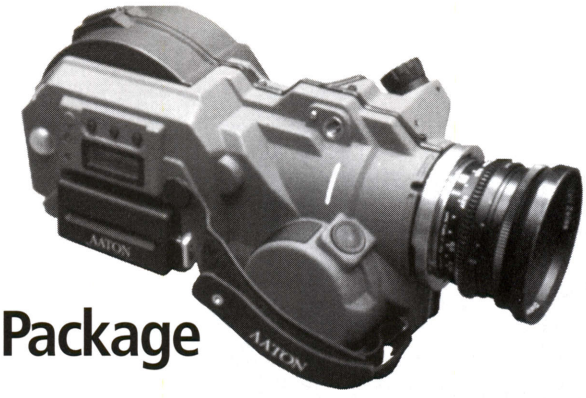


Big Breakthrough in a Small Package

by Eric Rudolph

Aaton Cameras, the French manufacturer of the popular LTR and XTRprod 16mm units, recently unveiled the A-Minima, a tiny, Super 16-only camera that at first glance resembles a high-tech cross between an up-to-the-minute DV camcorder and a vintage Bell & Howell spring-drive Filmo.

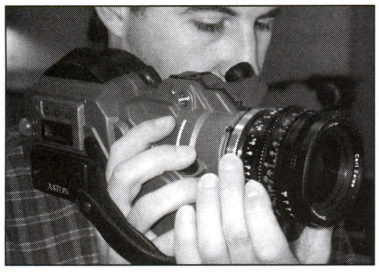
The startlingly small A-Minima is a mere 4¼" wide and 9½" long, and weighs less than five pounds with battery pack and 200' of film (sans lens). The camera features Aaton's popular AatonCode-II time code, offers the DistantEye reflex viewfinder, accepts PL lenses (as well as Nikon still-camera optics), operates on four CR123 3v lithium batteries, has a noise level of 27dB (compared to the XTR's 20dB), features a built-in intervalometer, and can run from 1 to 50 fps. The A-Minima is expected to be priced at about $15,000 (with one magazine), and should be available in January of 2000.

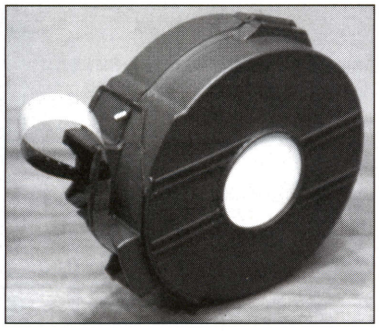
One of Aaton's distributors in the U.S. is Abel Cine Tech, which has offices in Staten Island, New York, and Burbank, California. Company head Peter Abel believes that the A-Minima could have a significant influence on aspiring filmmakers and their decisions about shooting with film or DV. "The A-Minima could be a focal point for university film programs that continue to teach film-based production," Abel says. "With the A-Minima, they can teach the most efficient and current film format — Super 16, complete with time code and automated synching. This makes sense because these are the same tools their students will use in the real world."

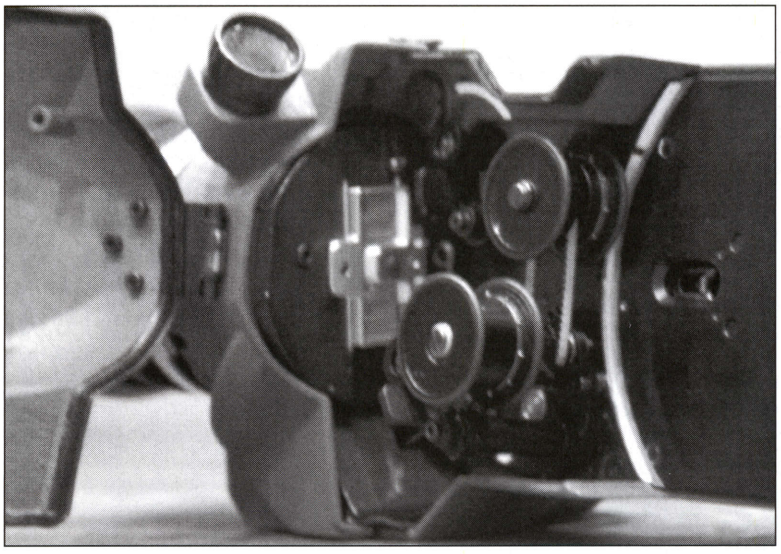
The idea that cinema students may use the A-Minima, and all of its accessories, during their introduction to filmmaking is "the most appealing aspect of this new camera," Abel enthuses.

Film schools and rental houses will be given first crack at purchasing an A-Minima, especially during the initial six months of its release. "At least in the beginning, we'd rather not have a lot of cinematographers buying the camera as a second or third unit and rarely using it — we want them in as many hands as possible, out in the world every day, being used to make films," Abel reasons.

The A-Minima employs a 200' coaxial magazine that requires a B-wind load on a special flexible-flange daylight spool (Eastman Kodak is working with Aaton to bring this special A-Minima load to the market, Abel says). The camera was designed to move the film in the magazine without the use of a torque motor. "The same shaft that holds the sprockets that drive the film also houses a roller that makes contact







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with the film reel and moves it as well," Abel explains, noting that this unusual concept was inspired by the design of the XTR's popular 800' magazine.

The A-Minima lacks a registration pin (as do all Aatons), but boasts the same image-steadiness specs as its bigger brothers. Abel notes that the coplanar claw movement and lateral pressure plate stabilization system produces steadiness of 1/2000 of image dimensions.

The Super 16 format was conceived by Scandinavian cameraman Rune Ericson in the late 1960s as a way to utilize the lower cost and lighter weight of 16mm cameras in shooting films that could be blown up to 35mm for exhibition, Abel explains.

Aaton Cameras was founded in 1971 by a team of researchers and technicians from a leading French cinematography company. Based in Grenoble, Aaton's design team (then led by Jean-Pierre Beauviala, Jacques Lecoeur, Robert Leroux and Hughues Vermeille) first developed the 16mm Aaton LTR 7, and later the LTR 54, one of the first cameras that could be easily converted to shoot in Super 16. (Beauviala also oversaw the design of the A-Minima.)

Super 16 (like its older and smaller cousin, Super 8, in relation to regular 8mm), uses more of the 16mm film's physical area for imaging, thereby requiring that less of the original picture be cropped when footage is blown up to 35mm in common theatrical exhibition formats (1.85:1 and 1.66:1). The standard 16mm aspect ratio is 1.33.1; Super 16's ratio is 1.66:1. The standard 16mm frame is 7.46mm x 10.26mm, while Super 16 frames are 7.46mm x 12.40 mm.

Because one set of sprocket holes on the emulsion is eliminated, the Super 16 image area is extended out toward the edge of the stock. This results in an increase in image size of 46 percent over standard 16mm when a Super 16 film is blown up to the 35mm 1.85:1 aspect ratio. For transfer to the 16:9 HD television aspect ratio, the increase in the onscreen image area with Super 16 is 44 percent, Abel explains.

In the format's early years, Super 16 was hampered by the fact that single-perf film had to be special-ordered; also, the vast majority of standard 16mm lenses would not cover the larger frame. All of that has changed, however. Single-perf 16mm film is available from both Kodak and Fuji as an off-the-shelf item, and most 16mm optics will now cover the larger Super 16 frame. Almost all major labs can also process the film, Abel assures.

Major filmmakers who have made successful theatrical features in Super 16 include Victor Nunez (*A Flash of Green, Ruby in Paradise, Ulee's Gold;* see *AC* June '97 for details on the latter) and Mike Figgis (*Leaving Las Vegas, The Loss of Sexual Innocence;* see *AC* Feb. '96 and April '99, respectively), among others. Nunez and Figgis are such ardent supporters of the format that both have said that they prefer it to 35mm.

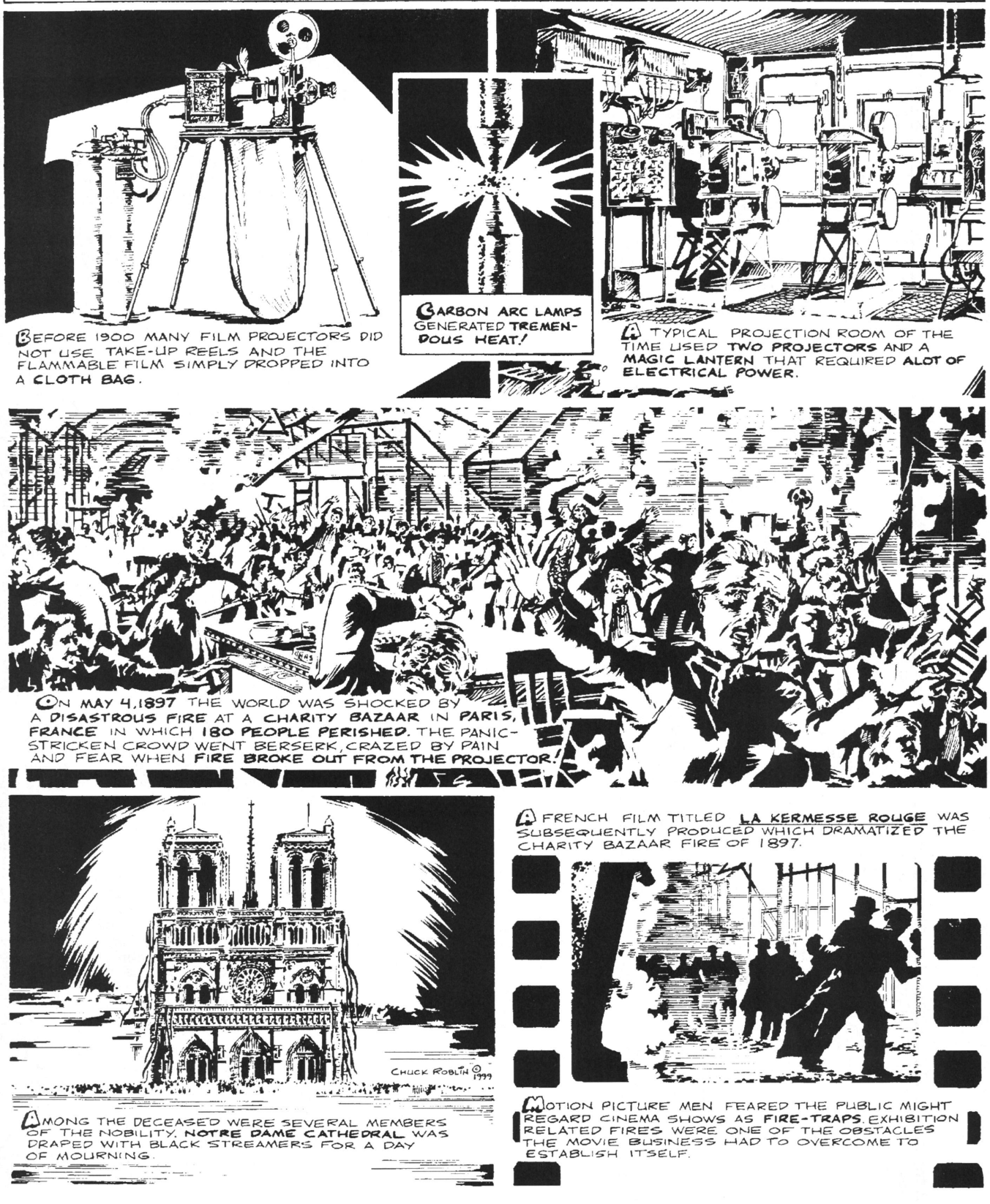
A major breakthrough for Super 16 came when it was embraced by series television, including such programs as the critically acclaimed *Homicide: Life on the Street* (see *AC* Oct. '95). Other shows have embraced the format as film stocks have improved, producing images that many say rival the look of 35mm. Many multiple-camera shows, such as ABC's *Sports Night*, now also film in Super 16, using Aaton's 800' magazines, which have the same efficient 22-minute running time as a 2,000' 35mm magazine.

While Peter Abel is an avid proponent of shooting on film and using the Super 16 format, he acknowledges that digital video also has a place in today's wide range of production methods. "There's something romantic about picking up a Mini-DV camera and making your first feature-length film," Abel muses. "That has great appeal for people with no budgets, and there's nothing to be ashamed of in using a Canon XL-1 to get a first project on its feet. However, what must be understood is that there are major differences in production value, image quality, look and feel between digital video and film."

Further specs and updates on the A-Minima can be found on Aaton's website at www.aaton.com. ■

FIRE!

by Ray Zone & Chuck Roblin



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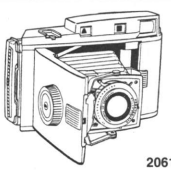
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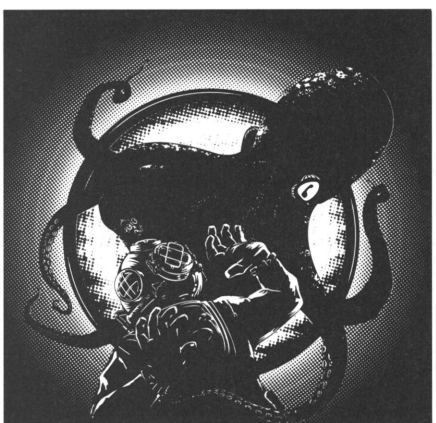
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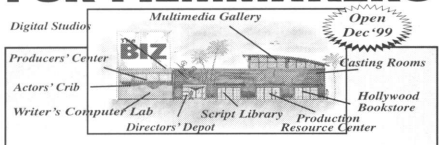

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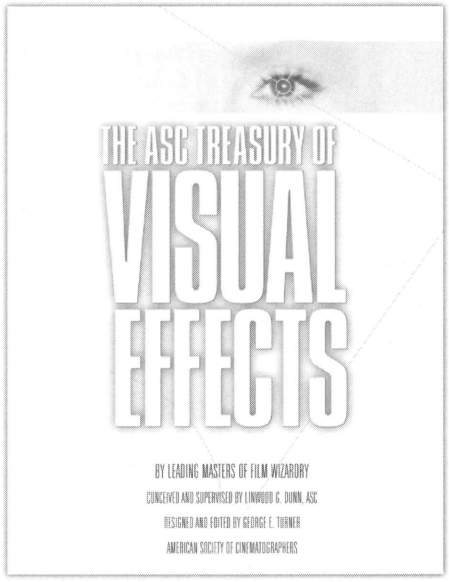

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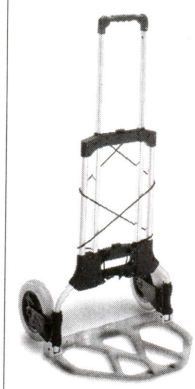

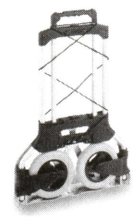

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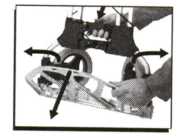

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In Memoriam

David Millin, ASC, one of only three ASC members to work and reside full-time on the continent of Africa, passed away in Johannesburg on May 26, 1999 at the age of 79. He had been an active member of the Society since 1972.

Millin designed and built the first camera crane used in South Africa, and was among the first in the country to use forced perspective, models, and complicated optical effects.

In a full and colorful career that spanned almost 60 years, Millin was regarded as one of the great pioneers of the South African motion picture industry. Born in Cape Town on June 11, 1920, he was educated at Selborne College in East London. A passion for photography brought him into the fledgling local film industry in 1941. He would later become a dominant force in shaping, defining and developing it.

Millin's began his career as a cameraman on weekly local newsreels, *African Mirror* and its Afrikaans language equivalent, *Ons Nuus (Our News).* He later went on to shoot scores of documentaries, and served as second-unit cinematographer on several major features, including *Cry, the Beloved Country.*

In 1956, he formed his own production company. Under his astute guidance and direction, many of those who worked on his early pictures went on to establish major careers for themselves both at home and abroad. As an independent producer/director, Millin made 14 feature films, many of them large-scale historical sagas. His biggest productions were made in conjunction with his long-time business partner and nephew, Roscoe C. Behrmann. These films, sweeping epics that were often based on actual events in Southern African history, included *Seven Against the Sun* (one of the first local films to be shot in CinemaScope), *Shangani Patrol, Majuba,* and *Die Vorrtrekkers (The Pioneers).* Fiction-based efforts included *Ride the High Wind, The Second Sin, Donker Afrika (Darkest Africa), Petticoat Safari, The Brave, the Rough, and the Raw; Sister Teresa* and *Banana Beach.* In the ensuing years, Millin served as director of photography on 19 motion pictures, including *Escape Route Cape Town, The Jakals* and *Killer Force.*

Millin was the recipient of numerous awards during his career, including the M-Net Cable Television Lifetime Achievement Award in 1994, and the South African Society of Cinematographers/Eastman Kodak Lifetime Achievement Award in 1997. He is survived by his wife Zelda, whom he married in 1945; his daughters, Melanie and Heather, and his sister, Doreen. The funeral took place at West Park Cemetery in Johannesburg on the morning of May 28.

— Lionel Friedberg

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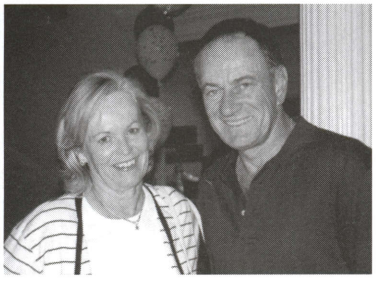
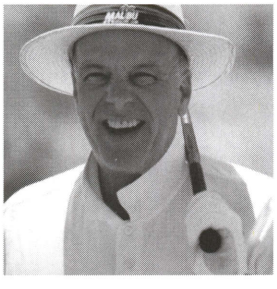
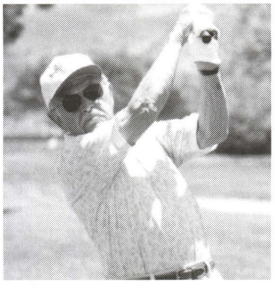
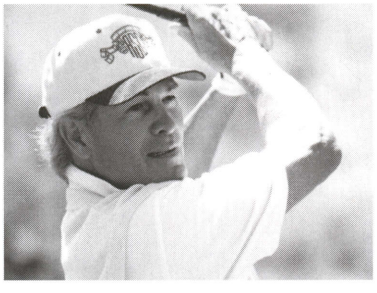
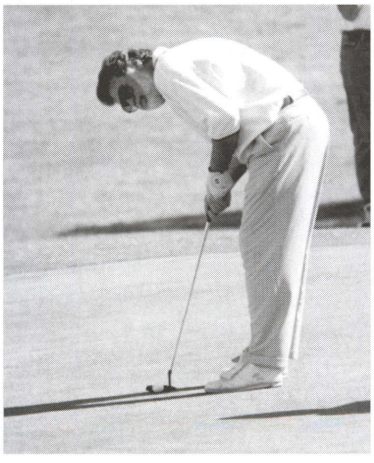
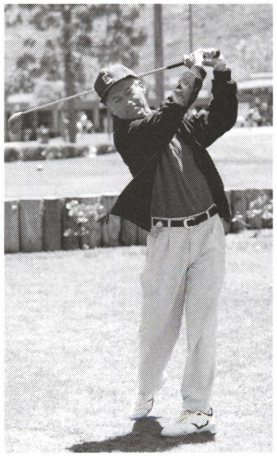










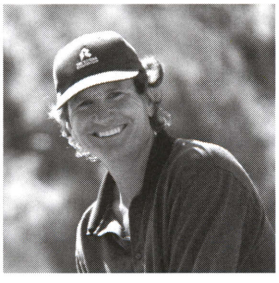


Photos by Tory Kooyman.

The 16th Annual ASC Golf Classic was held on June 13 at the Camarillo Springs Golf Course in Ventura County, California. The event, open to all ASC active members, associate members, and guests, began that morning with a "shotgun" start, as all foursomes teed up at the same time on 18 different holes — presumably with everyone hoping that *somebody* would win the special $10,000 "hole-in-one" prize. At midday, the participants enjoyed a barbecue lunch.

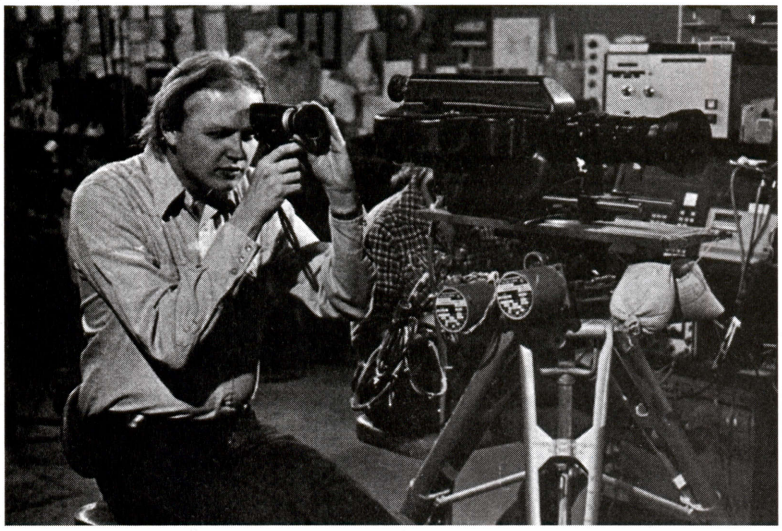
On June 21, the Golf Classic Wrap Party — complete with cocktails and dinner — was held at the ASC Clubhouse in Hollywood. After the various scoring computations were completed, trophies for the event's winners were presented by the chairman of the Golf Committee, Howard Anderson, Jr., ASC. Secondary prizes were given to all participating golfers.

With the help of the Callaway Handicap System, this year's winners were categorized into four distinct groups. ASC members: 3rd Low Net, Howard Anderson III (72); 2nd Low Net, Bradley Six (72); Low Net, Bobby Byrne (72); Low Gross, Owen Roizman (77). Associate members: 3rd Low Net, Al Mayer, Sr. (74); 2nd Low Net, Dick Aschmen (73); Low Net, John Bickford (84); Low Gross, Bill Bickford (84). Ladies: 3rd Low Net, Joanne Reeves (79); 2nd Low Net, Sandy Kuratobi (76); Low Net, Connie McKibbins (74); Low Gross, Mona Roizman, (91). Guests: 3rd Low Net, Bill Hunter (69); 2nd Low Net, Philip Downey (69); Low Net, Mark Morton (69); Low Gross, Jon Kunkel (70.5). ■



ASC members hit the links. From top: John A. Alonzo prepares to lay one up; Bobby Byrne shows off his Low Net trophy; Mona and Owen Roizman flash winners' grins after both earned awards for the family mantel; Charles Rosher, Jr. enjoys the day; Gene Polito gets into the swing; Steven Shaw hopes for a hole-in-one; Dean Cundey putts out; Woody Omens sends a ball aloft; Michael Margulies offers a smile; and Don Burgess enjoys a great day at Camarillo Springs.

WRAP SHOT



Right: Muren checks his light while setting up an effects shot for *The Empire Strikes Back* in 1979. The camera was ILM's "Empire-Flex" VistaVision unit, which was the only reflex 8-perf camera in the world at that time. Below: Muren (center) receives his star on the Hollywood Walk of Fame in 1999, surrounded by friends and colleagues, including James Cameron and Ray Harryhausen (front row, left), George Lucas (back row, right), C-3PO and R2-D2.

On June 3, Dennis Muren, ASC became the first visual effects artist to be honored with a star on the Hollywood Walk of Fame. The ceremony recognized the astonishing images he has helped devise for such films as *Star Wars, Close Encounters of the Third Kind, The Empire Strikes Back, Dragonslayer, Indiana Jones and the Temple of Doom, Return of the Jedi, The Abyss, Terminator 2, Casper,* and now, *Star Wars: Episode I — The Phantom Menace.*

Muren's skills as an effects cinematographer — honed through years of experimentation, study, and practical experience — made him a favorite colleague of the cameramen who handled principal photography on the aforementioned pictures. In discussing the making of *ET: The Extraterrestrial,* Allen Daviau, ASC credited Muren — the picture's visual effects supervisor — with successfully continuing the lighting design he had created for the film while executing its Academy-Award-winning effects work. "To have Dennis as a visual effects director of photography not only means that the effects work will be technically superb, but that those shots will be done in the overall photographic style of the film," Daviau remarked.

Today, however, with digital technology now so pervasive in the visual effects field, having a degree in computer science seems to be a requirement for anyone seeking to break into that competitive arena. Yet Muren — a self-taught expert whose early interest in applying computer graphics to filmmaking provided a great deal of impetus for the strides that have been made over the past decade — also believes that his traditional lighting expertise has enabled him to successfully utilize the digital techniques he helped pioneer.

Recalling his work in creating the computer-generated Tyrannosaurus Rex and velociraptors for *Jurassic Park,* Muren noted recently, "I was having trouble making them look really alive. Their motions were great, and their skin looked real, but they weren't as convincing and threatening as they would have been if I were standing there looking at the real thing. Then I realized that I could not see them *thinking* — I couldn't see their soul. What was missing? That question led to the obvious, time-honored answer: an eyelight. Because these were digital creatures lit with digital lights, I could have eyelights that illuminated only their eyes. I was able to light the animals as dramatically as I wanted and still see an evil glint in their eyes."

While Muren has previously been honored by AMPAS with a total of eight Oscar statuettes, and by BAFTA with two of their awards, the Walk of Fame Star perhaps signifies a new stage in the public's appreciation for the work of visual effects artists. The unveiling ceremony was witnessed by some 150 well-wishers, including effects experts Ken Ralston, Phil Tippett and Rick Baker, directors George Lucas and James Cameron, and legendary effects wizard Ray Harryhausen. In the midst of his eloquent speech to the crowd, Muren suggested that Harryhausen, one of his mentors, should be the next recipient of a Walk of Fame star — a proposal that prompted an enthusiastic vocal outburst from the gathered throng.

—David E. Williams

Photo by Albert L. Ortega

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